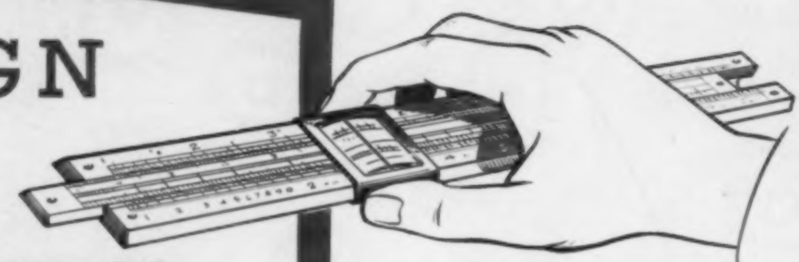
# MODERN PLASTICS

mp

NOVEMBER 1944

HEAD

# DESIGN DATA ON **PLASTICS**



## IX. Meeting Unusual Electrical Requirements

As it constitutes the complete answer to the unusual electrical and severe operating requirements of today's general service light companies and industrial power organizations, this case history concerning the Trumbull Type ATA Circuit Breaker should prove of tremendous interest to the imaginative designer and engineer.

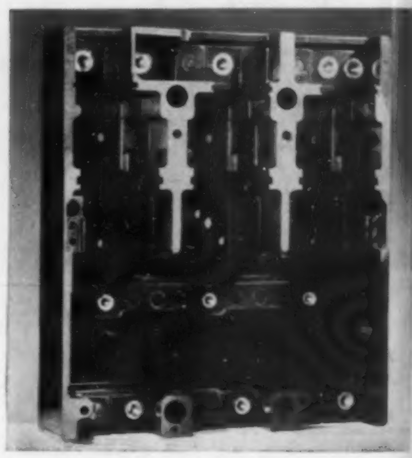
The development of this circuit breaker, as is the case in the successful development of all plastic products, centered around (1) the product designer, (2) the custom molder and (3) the manufacturer of plastic molding compounds.

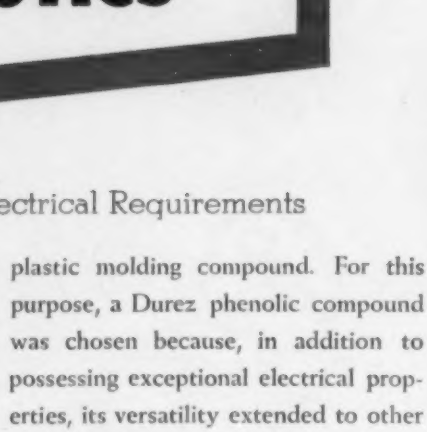
In this particular instance, the problem faced was unusually difficult because of the complex nature of the construction and the stringent requirements for electrical resistance and ruggedness in the material used.

As the first basic step, a mold design was worked out so ingenious that the circuit breaker case comes from its mold (compression molded by the Watertown Manufacturing Company) as a finished product, smooth and ready for assembly of internal mechanisms. Metal inserts, holes, sections, ribs, and cut-outs are *molded-in*, simplifying construction to an amazing degree.

Next came the careful selection of a plastic molding compound. For this purpose, a Durez phenolic compound was chosen because, in addition to possessing exceptional electrical properties, its versatility extended to other needed qualities such as impact strength, moisture resistance and moldability. *A plastic that fits the job*

The unusual versatility of the more than 300 Durez phenolic molding compounds has made their use practically universal throughout industry. As a result of this usage Durez laboratory technicians have gained a wealth of experience which embraces practically every field of endeavor.





Add to this extensive background the most modern methods of research and you can readily appreciate the value which their assistance has to the product designer and custom molder.

You may be assured of the utmost co-operation of the Durez staff, at any time, in helping your product designer and custom molder work out any materials problem which you may have. Durez Plastics & Chemicals, Inc., 511 Walck Road, North Tonawanda, N.Y.

DUREZ

PHENOLIC MOLDING COMPOUNDS AND RESINS

**PLASTICS THAT FIT THE JOB**

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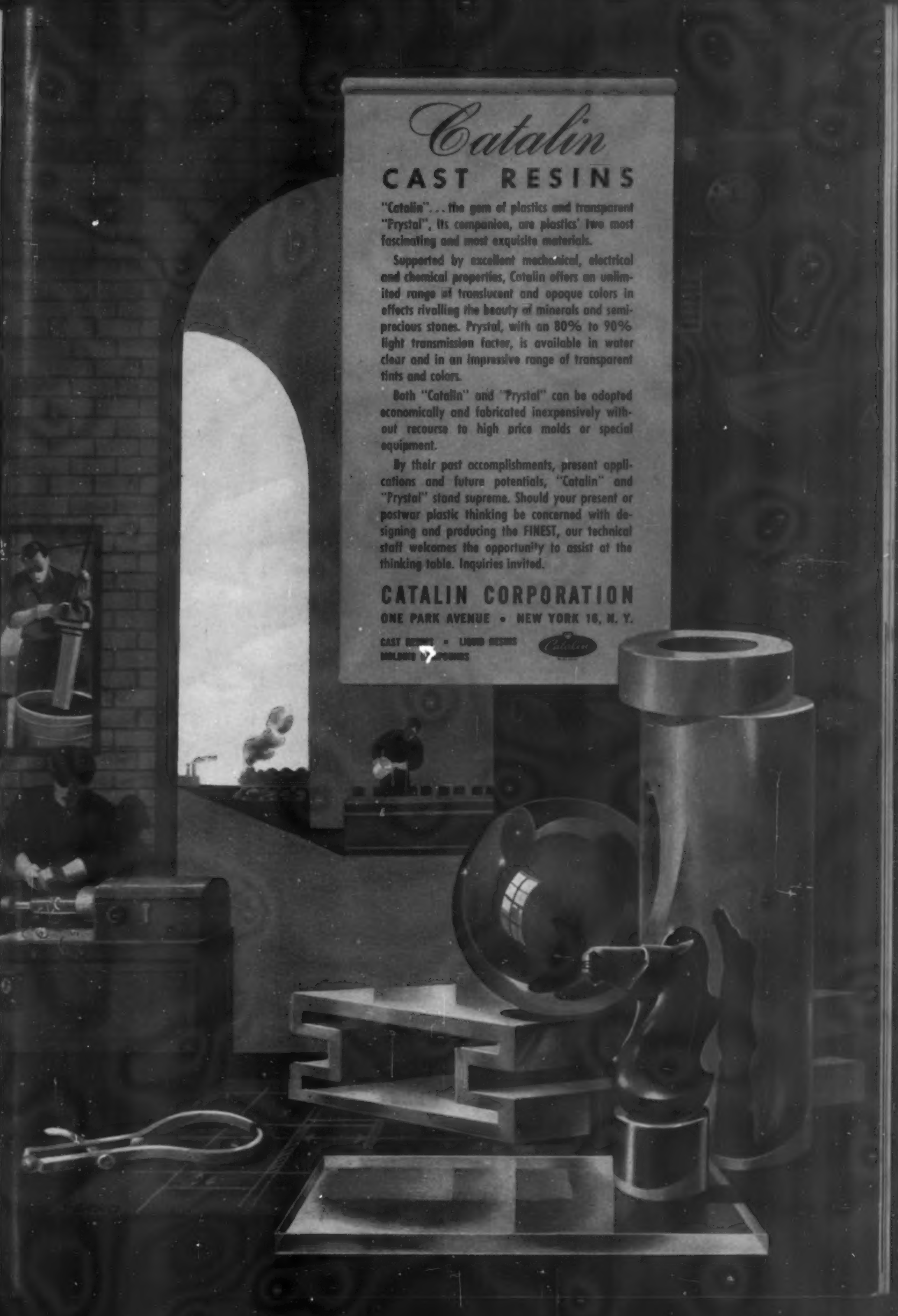

# MODERN PLASTICS

AND PLASTICS



All editorial contents bearing on military subjects have been released for publication by the Armed Services.

MODERN PLASTICS is regularly indexed in the Industrial Arts Index.

*Member Audit Bureau of Circulations*

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VOLUME 22 — NOVEMBER 1944 — NUMBER 3

## *General Section*



## *Plastics—Engineering Section*



## *Technical Section*



## *News and Features*


# Richardson Plasticians put an end to this Whispering Campaign

They've taken the mystery out of forming Laminated INSUROK plastic sheets! For actually it is a simple process . . . one you can do yourself if you *know how*. And here is a small booklet that puts you in the know . . . the A B C's of how to form laminated plastic sheets yourself.

*It is as easy as this:*

**A. HEAT the laminated sheet uniformly slightly below the blistering point.**

**B. INSERT the heated sheet in the forming fixture and apply pressure.**

**C. ALLOW part to cool and then remove.**

*Result . . . the shape is now permanent.*

Laminated INSUROK plastic sheets for forming have varied uses. They combine strength with lightness . . . are resistant to sudden changes in temperature . . . withstand the destructive actions of most chemicals, reagents, and solvents.

Write today for the booklet that tells all about forming laminated plastic sheets . . . "*HOW TO FORM LAMINATED INSUROK SHEETS.*" It's FREE for the asking. Send for it on your company letterhead.

**You may prefer to have the forming done for you. If so, the working knowledge and years of practical experience of Richardson Plasticians are at your disposal.**

**INSUROK** *Precision Plastics*

## The RICHARDSON COMPANY

MELROSE PARK, ILL. NEW BRUNSWICK, N. J. FOUNDED 1888 INDIANAPOLIS 1, IND. LOCKLAND, CINCINNATI 15, OHIO
DETROIT OFFICE: 6-252 G. M. BUILDING, DETROIT 2, MICHIGAN NEW YORK OFFICE: 75 WEST STREET, NEW YORK 6, N. Y.
CLEVELAND OFFICE: 326-7 PLYMOUTH BLDG., CLEVELAND 15, OHIO

# FLEXOL *Plasticizer* 4GO

## A NEW PLASTICIZER
### *Now in Commercial Production*

**This new plasticizer is outstanding because . . .**

1. It has extremely low volatility.
2. It imparts superior low-temperature flexibility.
3. It is highly efficient.

Flexol Plasticizer 4GO (Polyethylene Glycol Diethylhexoate) is compatible with vinyl chloride, nitrocellulose, vinyl acetate, and ethyl cellulose resins, and is particularly efficient with vinyl chloride-acetate films.

## Other Plasticizers in the Flexol Family

**Flexol Plasticizer DOP** (Dioctyl phthalate, Diethylhexyl phthalate) is one of the best all-round plasticizers made today, particularly because of its low evaporation rate (1/40th that of dibutyl phthalate). It is highly efficient with neoprene and the vinyl resins, and with nitrocellulose gives a film with as much as 50 per cent higher tensile strength for the same degree of flexibility. It is extremely resistant to water extraction, produces good low-temperature flexibility, and has excellent light and heat stability. Its power factor and dielectric constant are outstanding. Flexol DOP is also used to couple less compatible plasticizers in plastic compositions.

**Flexol Plasticizer 3GH** (Triethylene glycol diethylbutyrate) is particularly useful in safety-glass films, like those of vinyl butyral resins, because of its clarity, light stability, and its ability to improve the adhesion of the resins to the glass. Resins plasticized with Flexol 3GH have outstanding low-temperature flexibility.

**Flexol Plasticizer 3GO** (Triethylene glycol diethylhexoate) is similar to Flexol 3GH but is less volatile. Thus, it is useful in surface coatings and in molded and extruded compositions where greater plasticizer retention is required. Flexol 3GO develops excellent flexibility at low temperatures. It is a useful plasticizer for cellulose acetatebutyrate, vinyl chloride-acetate and vinyl butyral resins, and synthetic rubbers such as Neoprene and Thiokol ST.

***For further information write for the new booklet describing the Flexol Plasticizers.***

*BUY UNITED STATES WAR BONDS AND STAMPS*

SYNTHETIC ORGANIC CHEMICALS

**CARBIDE AND CARBON CHEMICALS CORPORATION**

*Unit of Union Carbide and Carbon Corporation*

UCC

**30 East 42nd Street, New York 17, N. Y.**

"Flexol" is a registered trade-mark of Carbide and Carbon Chemicals Corporation.

"You Don't Say!"

# Chemaco HAS 4 MOLDING POWDERS!

They are four of the most widely used thermoplastics, each suited to specific applications. The Chemaco group offers you a plastic to meet almost any requirement for injection, compression or extrusion molding. Use Chemaco engineers to select the correct plastic.

★ CHEMACO CELLULOSE ACETATE—A tough strong plastic with fine lustrous finishes. Noted for impact strength, unlimited color range, and warmth to the touch. Suitable for flash-light cases, panels, decorative trim, combs, vacuum cleaner parts and many other uses.

★ CHEMACO ETHYL CELLULOSE—An exceptionally strong plastic having great impact strength and dimensional stability at low temperatures. Ideal for tool handles, automotive, radio, refrigerator and vacuum cleaner parts, in addition to extruded trim.

★ CHEMACO POLYSTYRENE—in waterclear crystal and colors. Offers resistance to chemicals, high dielectric strength and low water absorption. Ideal for electrical, chemical and medical equipment parts. Absence of taste and odor makes it essential in refrigerator parts, closures, containers and dispensers.

★ CHEMACO VINYL COMPOUNDS—Elastomeric and rigid, characterized by great resistance to abrasion, are non-flammable and self-extinguishing. Resistant to chemicals and water and adaptable for uses replacing rubber.

## Chemaco Corporation

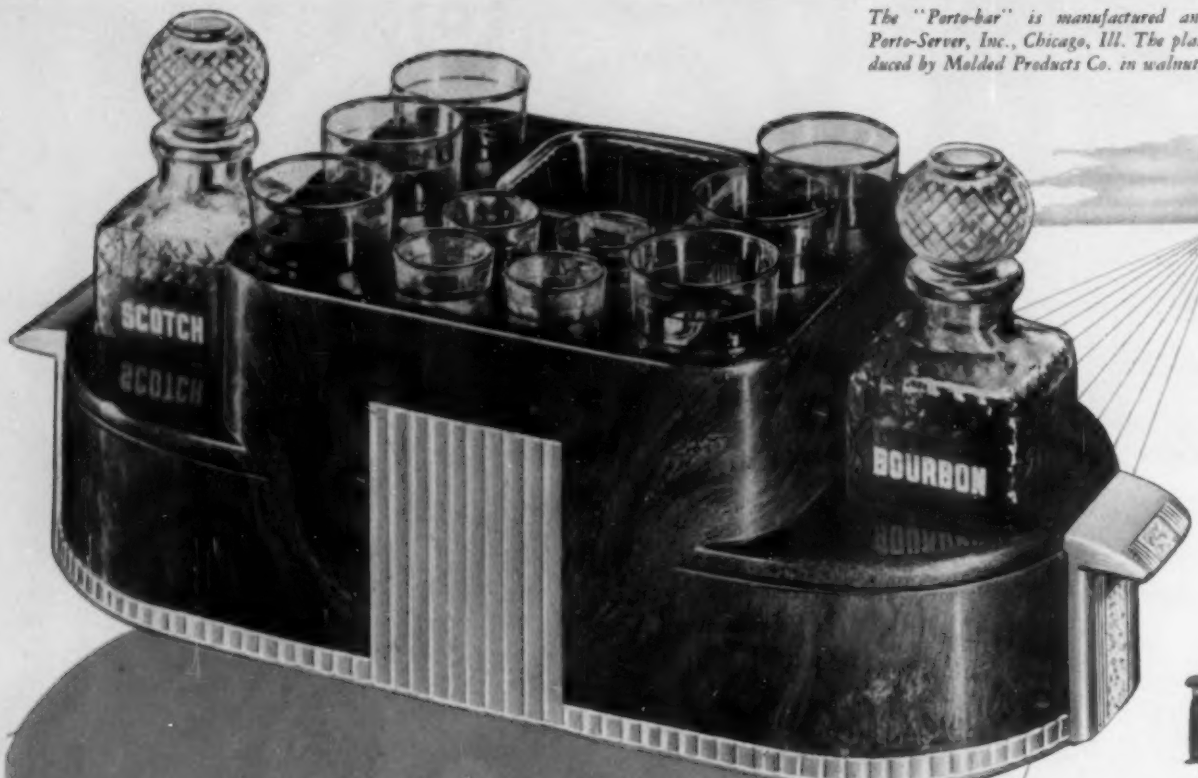
*(A subsidiary of Manufacturers Chemical Corporation)*

**Berkeley Heights, N. J.**

Branch Office—Cleveland, O. Representatives—Machinery Sales Company, Los Angeles · San Francisco

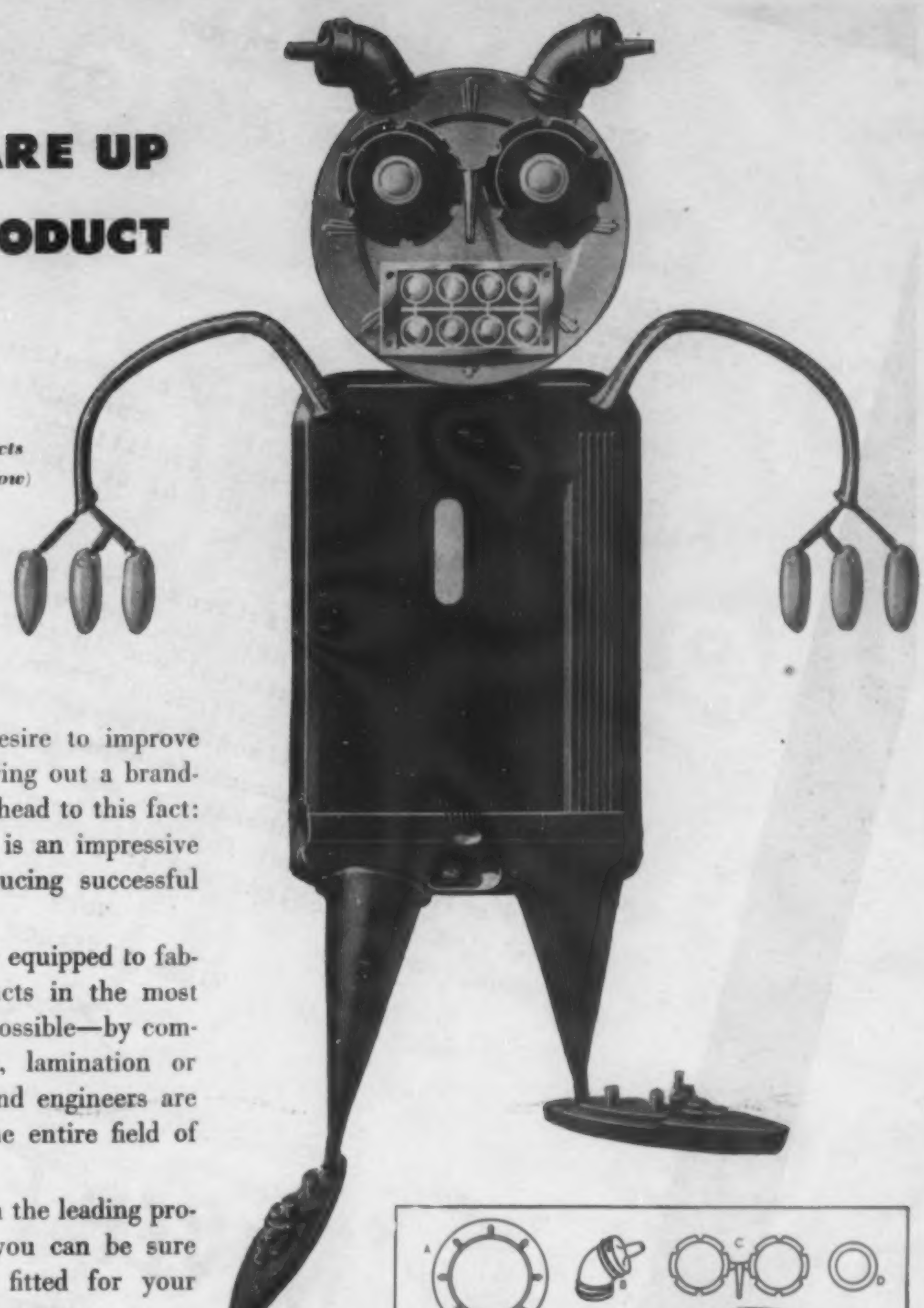


*The "Porto-bar" is manufactured and distributed b Porto-Server, Inc., Chicago, Ill. The plastic body was produced by Molded Products Co. in walnut, ebony and ivory*




# HOW TO SCARE UP A BETTER PRODUCT

*(Can you name the different products in this scarecrow? See chart below)*



*If you're haunted* by the desire to improve your present product or to bring out a brand-new product, don't hide your head to this fact: Back of our Plastics Division is an impressive record of planning and producing successful plastic products.

Not only is Continental now equipped to fabricate a wide range of products in the most efficient and economical way possible—by compression, injection, extrusion, lamination or sheet forming; its designers and engineers are among the most skillful in the entire field of plastics.

These men work closely with the leading producers of raw materials. So you can be sure we'll select the plastic best fitted for your requirements.

No matter what qualities your design calls for—beauty, toughness, lightness, durability or any others—come to Continental. You'll find an alert, progressive organization equipped to give sound, practical advice and assistance at all times!


(a) Dish—compression; (b) Nozzle for intravenous bottle—compression; (c) Color lenses—injection; (d) Button—injection; (e) Label holder—injection; (f) Flashlight lenses—injection; (g) Billing machine housing—compression; (h) Air scoop mounting—compression; (i) Funnel—compression; (j) Fishing lures—injection; (k) Toy boat—injection.

**CONTINENTAL** **CAN COMPANY, INC.**

**PLASTICS DIVISION**

**HEADQUARTERS: Cambridge, Ohio**

**Sales Representatives in all Principal Cities**

**COMPRESSION · INJECTION · EXTRUSION**
**SHEET FORMING · LAMINATION**

***To give you the best** in plastics service, Continental has acquired Reynolds Molded Plastics of Cambridge, Ohio. The facilities of this pioneer organization combined with Continental's extensive resources form a Plastics Division capable of designing, engineering and producing the widest range of plastic products for manufacturers and designers.**

# BAKELITE

TRADE-MARK

## Two Moving Parts Instead of Twelve

THE NEW BALL-COCK VALVE molded of BAKELITE polystyrene plastics is a remarkable example of the result of revised thinking applied to an old product. The difficulty of making metal replacements for worn and corroded valves suggested the use of plastics. Plastics, in turn, called for a simplified, readily moldable design.

As redesigned, the new valve of BAKELITE polystyrene has only two moving parts as compared to some twelve in its metallic forebears. It takes but four ounces of polystyrene —a 90 per cent saving in weight, as former valves used 40 ounces of copper and brass. Parts for two complete units come from the injection molding machine on one sprue every 35 seconds. Threads are *molded* on the main connection and ball ends. Only female threads must be tapped by hand in the assembly units. Production costs are greatly lowered, for in metal valves each part had to be cast, machined, drilled, tapped, and male threads cut by hand, before assembly. And besides simplicity of design and ease of production, this plastic valve is thoroughly dependable, assuring long-term service. It is fully resistant to corrosion and scale, the chief troublemakers and causes of failure in the past.

This improved ball-cock valve shows the value of teamwork between designers, fabricators, and material suppliers. If you have a product that must resist corrosion, one of the many BAKELITE plastics is likely to be the answer. Other characteristics in the material might bring further improvements; and, of course, the use of plastics often reduces production costs. Our Field Engineers and Development Laboratories will be glad to work with you on essential problems at any time. Write for Booklet 15-M that describes BAKELITE molding plastics.

TRADE MARK

BAKELITE CORPORATION

*Unit of Union Carbide and Carbon Corporation*

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30 EAST 42ND STREET, NEW YORK 17, N.Y.

# Polystyrene Plastics

# A FAST-CUTTING, SMOOTH-FINISHING MILLED TOOTH FILE FOR LARGE PLASTICS PARTS

The use of plastic materials, both molded and laminated, is rapidly being applied to larger and larger parts and product units. Forming dies and molds, irregular housings, for instance. These invariably require a lot of hand finishing . . . for which smoothing files with a fast-cutting shearing action are the logical thing.

In this classification, where large surfaces are to be filed, there's nothing more efficient than today's Nicholson Superior Curved Tooth Files. Improved file-cutting machinery—made only by Nicholson—*mills* in the teeth with an accuracy, uniformity, and sharpness never before achieved in files of this type. Rake and clearance are ideal for work on plastics. And exclusive Nicholson toughening and hardening methods keep the teeth cutting longer under the peculiar abrasive action of most types of plastics.

Besides plastics, Nicholson Superior Curved Tooth Files are used on aluminum, magnesium, babbitt, brass, lead, hard rubber, wood, soft alloys, cast iron, sheet steel and commercial annealed tool steel. *Rigid* tanged type in flat, square, pillar and half-round cross section. *Flexible* type for use in special holders, for flat, concave and convex surfaces. Order through your mill-supply house.

*Send for Catalog Sheet of available types and sizes*—and for file recommendations for any special plastics filing problem you may have.

**NICHOLSON FILE COMPANY, 44 ACORN STREET, PROVIDENCE 1, R. I., U. S. A.**

*(Also Canadian Plant, Port Hope, Ont.)*

**NICHOLSON FILES** *FOR EVERY PURPOSE*

NICHOLSON U.S.A. MADE IN U.S.A.

**DEVOE & RAYNOLDS** apply cellulose acetate over rayon cord, producing paint brush bristles that are unaffected by the solvents in paints and varnishes.

**NITROCELLULOSE IS** the choice of fountain pen makers. It resists corrosion of inks and is dimensionally stable—will not cause leakage by swelling or warping.

**THE WORLD'S LARGEST** glider canopy gives dramatic proof of cellulose acetate's stability. It retains its exact dimensions and clear transparency in all kinds of weather.

# CELLULOSE PLASTICS ARE *STABLE!*

Characteristically, the versatile cellulosics are stable to the greatest number of conditions. They are in frequent use where resistance to acids, gasoline, oils, and alcohols is demanded. They withstand exposure not only to the normal elements, but to the greatest extremes of humidity and temperature under which man himself can survive. They can be economically fabricated to maintain modern production tolerances. This rare combination of important properties explains the popularity of these versatile materials for thousands of uses in plastics. While Hercules does not make plastics themselves, it does supply those who do with the finest quality base materials—cellulose acetate, cellulose nitrates and ethyl cellulose. For information gained through years of research, write Cellulose Products, Dept. MP-114, **Hercules Powder Company, Wilmington 99, Delaware**

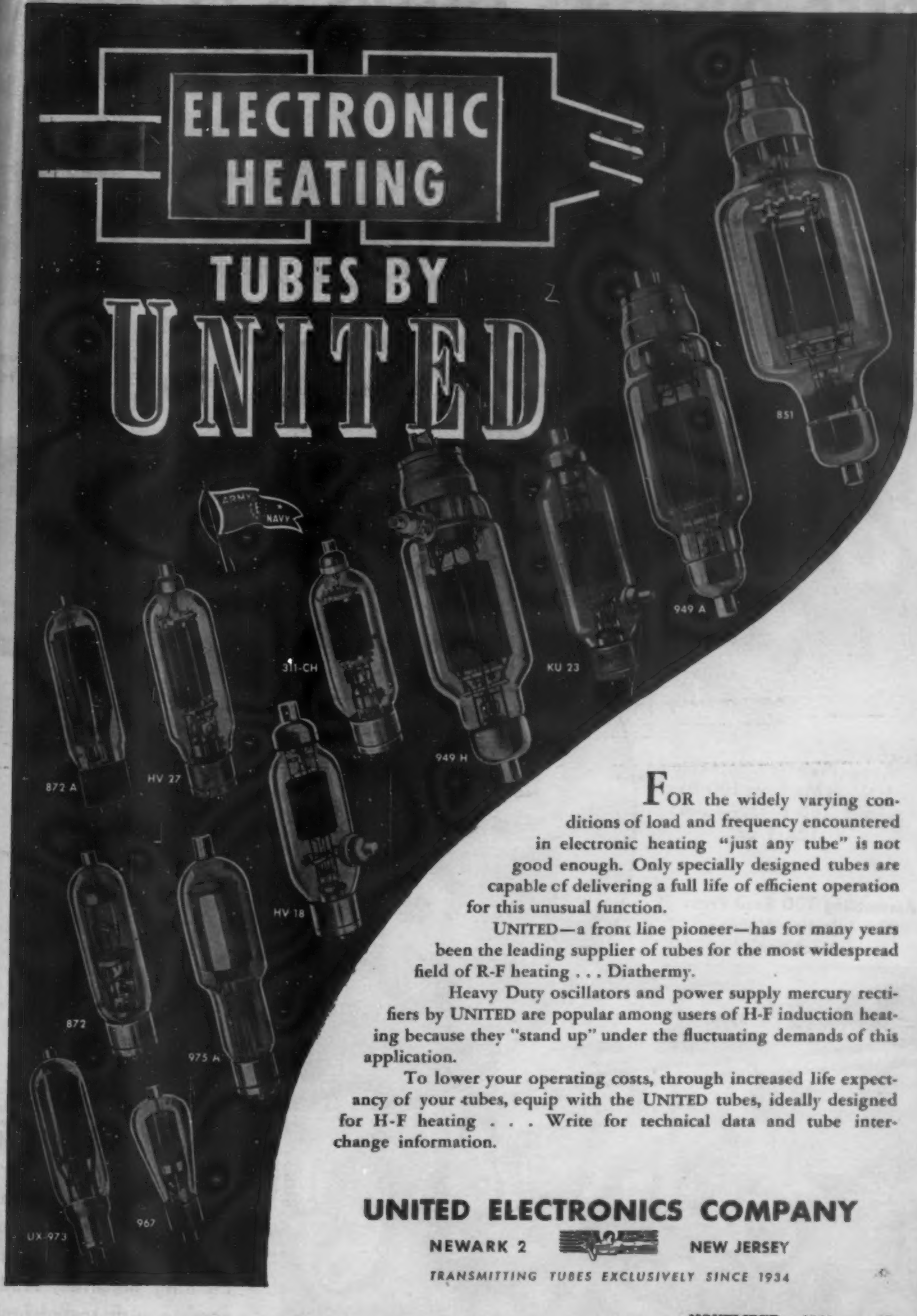
**TOUGH · FLEXIBLE · STABLE · CLEAR · ECONOMICAL · LIGHTWEIGHT**

**HERCULES ETHYL CELLULOSE PLASTIC PEEL** protects the delicate surfaces of finely machined metal parts from any and all conditions of humidity, temperature, and exposure to salt water. Ethyl cellulose can do it because it is *stable* to these extreme conditions.



*HERCULES*

**CELLULOSE ACETATE**
**CELLULOSE NITRATE**
**ETHYL CELLULOSE**




FOR the widely varying conditions of load and frequency encountered in electronic heating "just any tube" is not good enough. Only specially designed tubes are capable of delivering a full life of efficient operation for this unusual function.

UNITED—a front line pioneer—has for many years been the leading supplier of tubes for the most widespread field of R-F heating . . . Diathermy.

Heavy Duty oscillators and power supply mercury rectifiers by UNITED are popular among users of H-F induction heating because they "stand up" under the fluctuating demands of this application.

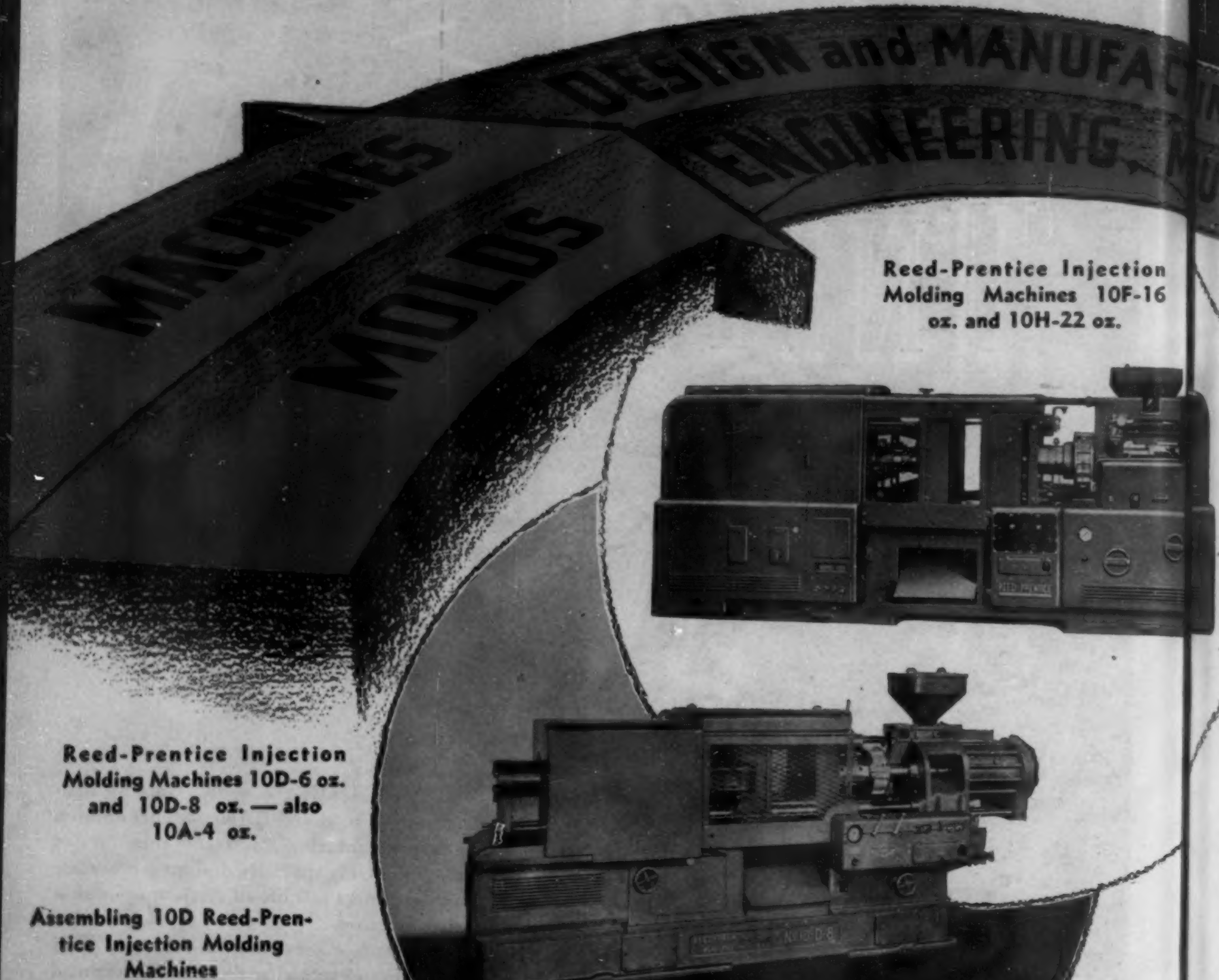
To lower your operating costs, through increased life expectancy of your tubes, equip with the UNITED tubes, ideally designed for H-F heating . . . Write for technical data and tube interchange information.

**UNITED ELECTRONICS COMPANY**

NEWARK 2 NEW JERSEY

*TRANSMITTING TUBES EXCLUSIVELY SINCE 1934*

# REED-PRENTICE OFFERS A COMPLETE SERVICE IN INJECTION MOLDING . . .




Reed-Prentice Injection Molding Machines 10F-16 oz. and 10H-22 oz.

Reed-Prentice Injection Molding Machines 10D-6 oz. and 10D-8 oz. — also 10A-4 oz.

Assembling 10D Reed-Prentice Injection Molding Machines

**Reed-Prentice completes the circle of service for the molder, right from the design of the mold straight through to the injection molding machine, ready to operate with tested molds.**

# THERE ARE A THOUSAND USES FOR SYNTHANE LAMINATED PLASTIC TUBING

## *Tubing is the start in the production of many products*

**SYNTHANE TUBING** is produced in various shapes, diameters, wall-thicknesses, lengths, colors and finishes. The uses of tubing, simply as tubing, however, are obviously limited. It is imagination and machining plus a combination of many desirable properties that make Synthane tubing the useful material it is. Tubes can be easily and quickly machined into coil forms, fuse cases, chemical piping, motor brush holders, bushings, ferrules, ball bearing retainers, pump valves and a legion of other products. Tubing, then, is the first step in the ready and economical production of many parts.

Machining can be done by you or by us. Many prefer us to handle the complete job to relieve them of the responsibility for dies, jigs, tolerances, and other production details.

### PROPERTIES—GENERAL (Varies with grades)

**PHYSICAL:** Hard, Rockwell M-60 to M-100, dense, uniform. Light in weight (specific gravity 1.1 to 1.3), non-hygroscopic, (24 hour water absorption 0.5 to 5.0 per cent). Stable over wide temperature range. Low coefficient of thermal conductivity.

**MECHANICAL:** High tensile, compressive and crushing strength. High resistance to rupture (under internal pressure). May be easily sawed, turned, punched, riveted, drilled, reamed, milled, threaded, tapped or polished.

**ELECTRICAL:** High dielectric strength, low dielectric constant, low power factor, low loss factor.

**CHEMICAL:** Resists common solvents, oils, weak acids. Will not corrode metal inserts, bushings, ferrules, etc.

### Kinds of stock, properties

There are three principal kinds of SYNTHANE tubing, classified according to the materials used in their manufacture:

1. The paper base grades—X and XX.
2. The fabric base grades—C, CE, L and LE.
3. The asbestos base grades—A and AA.

The properties and characteristics of SYNTHANE tubing depend mainly upon the base used, the type of resin and the time of cure. By combining the raw materials and varying the method of manufacture, it is possible to alter the physical, mechanical, electrical or chemical properties, strengthening one without wholly sacrificing the others, to secure the exact balance of properties required.

The services of SYNTHANE engineers are at your disposal to aid in selecting or developing tubing to meet your particular needs.

### Special shapes

Special tubular sections can be produced in a wide variety of forms by applying the basic principles of tube molding. SYNTHANE sections, being laminated, are considerably stronger than ordinary powder molded shapes.

The simplest molded-laminated shapes are square, rectangular or oval. More intricate examples include horns, cones and irregular inside or outside contours.

**Automatic screw machining can be advantageously used for low cost quantity production of numerous parts from Synthane tubing.**

**From tubes like these . . .**

**products like these ➡**

SHEETS • RODS • TUBES • FABRICATED PARTS **SYNTHANE** MOLDED-LAMINATED • MOLDED-MACERATED

***Plan your present and future products with Synthane Technical Plastics***

**SYNTHANE CORPORATION, OAKS, PENNA.**

REPRESENTATIVES IN ALL PRINCIPAL CITIES

## Part of Our Facilities Are Now Released for Peace Time Production


SIX SEPARATE MANUFACTURING DIVISIONS FOR LARGE SCALE PRODUCTION

•

ENGINEERS, DESIGNERS, CHEMISTS WITH FACILITIES FOR PRODUCING METAL AND PLASTIC PARTS, AND ASSEMBLIES.

•

WE ARE ENGAGED LARGELY IN WAR WORK BUT ARE GLAD TO TALK WITH MANUFACTURERS WHO ARE LOOKING AHEAD TO RECONVERSION AND NEW PRODUCTS

ADDRESS YOUR INQUIRIES TO DEPT. B

•

**BUY MORE WAR BONDS • HASTEN VICTORY**

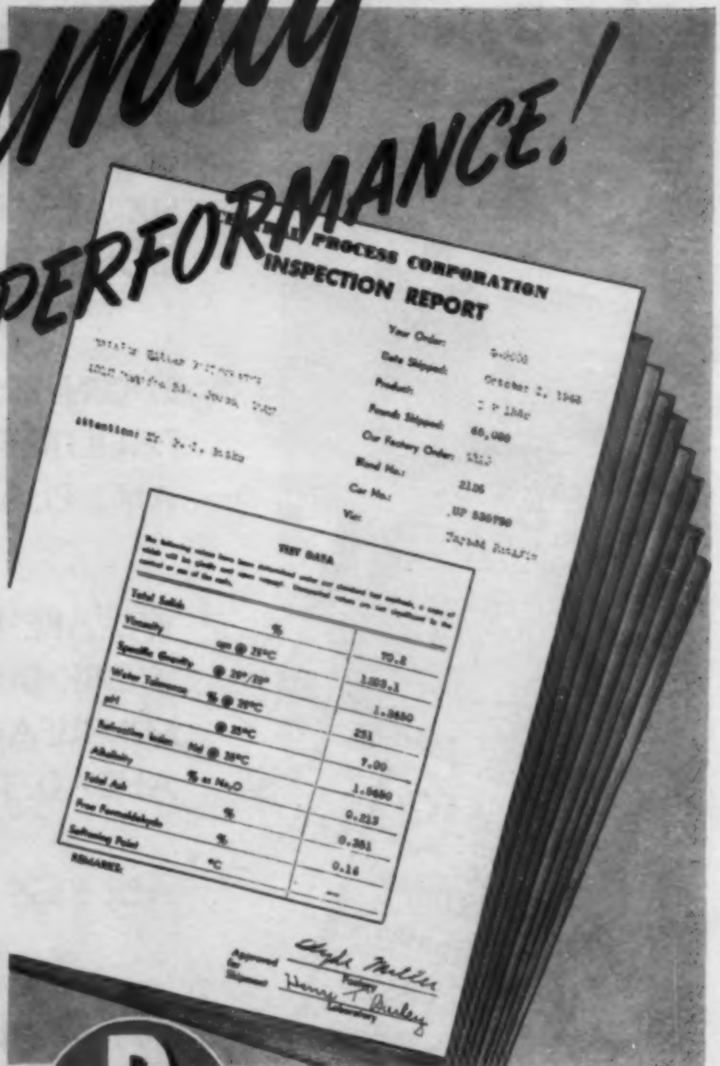
WC INC 1812

**WATERBURY COMPANIES, INC.**
*Formerly Waterbury Button Co., Est. 1812*
WATERBURY, CONNECTICUT

**W**HEN A RESIN is scientifically prepared for *one specific application*—job tested—and its production *stabilized*—ONLY THEN is dependable uniformity in performance achieved.

LARGE INDUSTRIAL USERS depend on C.P.C. for *dependable resin performance* because C.P.C. specializes in the development of resins for specific applications—AND—because C.P.C. so *stabilizes* production of *each* specification resin that the performance of *every shipment delivered is identical with the first.*

# CPC Guarantee of... Uniformity IN PERFORMANCE!




THE EXTREMELY CLOSE RANGE of variation within which C.P.C. Resins are held is evidenced by a control laboratory inspection report—*with each shipment*—showing the complete chemical characteristics of the resin.

Resin properties, *exactly* fitted to *any one* of a wide variety of applications, can be produced (C.P.C. produces them) because the phenols, aldehydes or ketones and catalysts from which phenolic resins are obtained can be varied in an almost infinite number of combinations. And—when the desired resin properties are produced—they CAN be held within a range that assures uniform performance. C.P.C. has proved—and *is* proving this *every day!*

**IF YOU HAVE A RESIN PROBLEM**

Draw freely upon the wide experience of C.P.C. We will gladly work with you on any resin problem, or discuss with you the possible advantage of using resins in any operation or process. Write Central Process Corporation, 1401 Circle Ave., Forest Park, Ill.

CPC

CENTRAL PROCESS CORPORATION

● Each shipment of C.P.C. resin carries its own analytic inspection report from C.P.C. Control Laboratory. Thus you can be sure of the *uniformity in performance* of the shipment you receive today—or a year from today. No other supplier provides this exacting evidence of production control.

# Battle eyes at work...


Official U. S. Navy Photograph—Wide World Photos

Binoculars: Courtesy of Carbide and Carbon Chemicals Corporation

## Plastic sheeting CORDO-BONDED to aluminum bodies

For more than two years, CORDO-BOND Adhesives have been highly successful in bonding Vinylite* Sheeting to aluminum binocular bodies and brass spy-glass bodies.

CORDO-Bonding meets all government tests to which these glasses are subjected: extreme temperatures, humidity, saltspray, impact . . . stands up in the hands of our Army and Navy on fighting fronts throughout the world.

Perhaps CORDO-BOND Adhesives can solve some of your present or post-war problems in bonding *metals, plastics, wood, glass, paper, cloth* or *leather.*

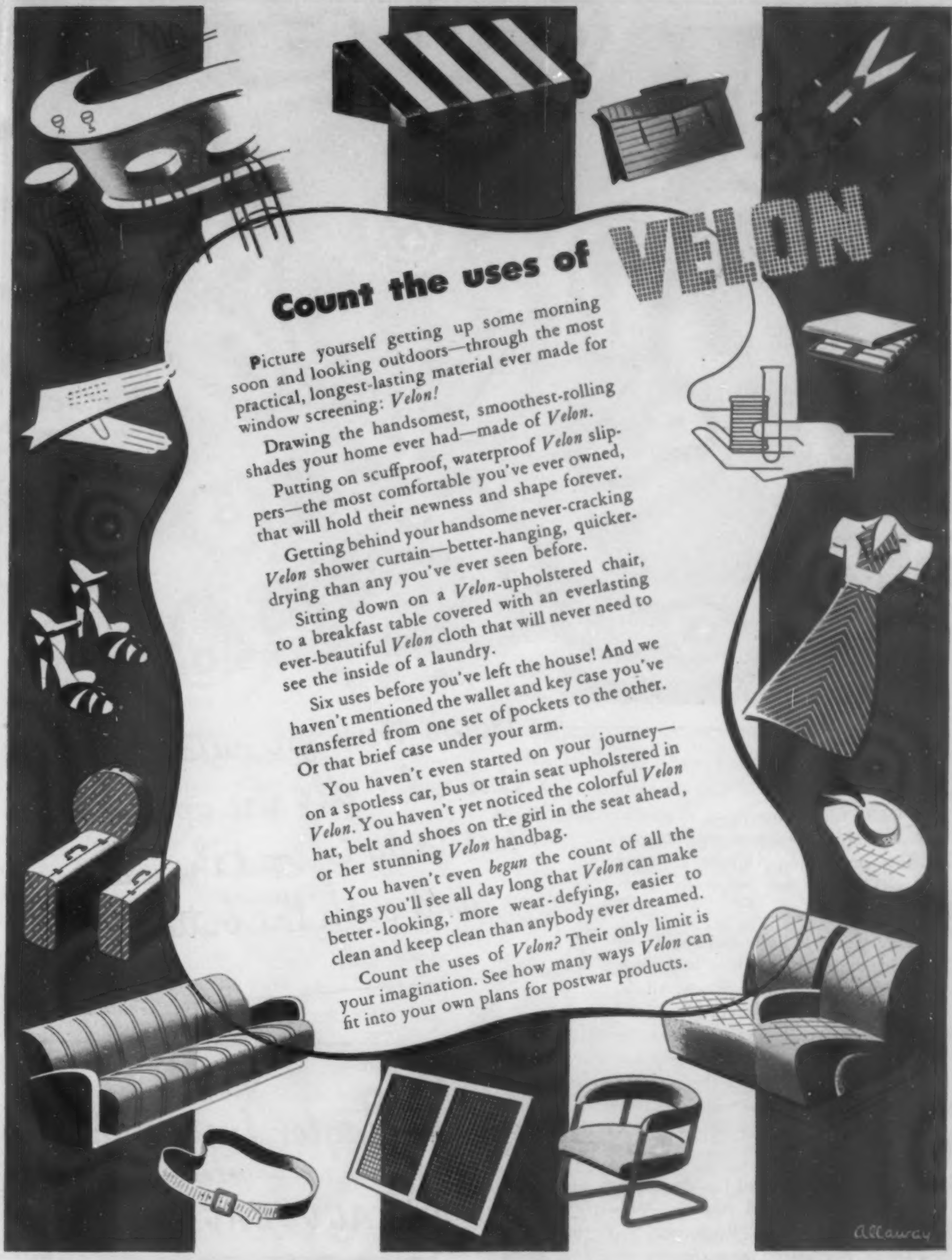
Please write, giving details for exact analysis or request Catalogue of CORDO-BOND Adhesives, uses, characteristics, bonding processes.

*VINYLITE IS THE REGISTERED TRADE MARK OF CARBIDE AND CARBON CHEMICALS CORPORATION

**CORDO CHEMICAL CORPORATION**
**34 Smith St., Norwalk, Conn.**

INDUSTRIAL COATINGS • FINISHES
INDUSTRIAL ADHESIVES

# CORDO-BOND


Count the uses of VELON
Picture yourself getting up some morning soon and looking outdoors—through the most practical, longest-lasting material ever made for window screening: *Velon!*
Drawing the handsomest, smoothest-rolling shades your home ever had—made of *Velon*.
Putting on scuffproof, waterproof *Velon* slippers—the most comfortable you've ever owned, that will hold their newness and shape forever.
Getting behind your handsome never-cracking *Velon* shower curtain—better-hanging, quicker-drying than any you've ever seen before.
Sitting down on a *Velon*-upholstered chair, to a breakfast table covered with an everlasting ever-beautiful *Velon* cloth that will never need to see the inside of a laundry.
Six uses before you've left the house! And we haven't mentioned the wallet and key case you've transferred from one set of pockets to the other. Or that brief case under your arm.
You haven't even started on your journey—on a spotless car, bus or train seat upholstered in *Velon*. You haven't yet noticed the colorful *Velon* hat, belt and shoes on the girl in the seat ahead, or her stunning *Velon* handbag.
You haven't even *begun* the count of all the things you'll see all day long that *Velon* can make better-looking, more wear-defying, easier to clean and keep clean than anybody ever dreamed.
Count the uses of *Velon?* Their only limit is your imagination. See how many ways *Velon* can fit into your own plans for postwar products.
Allaway


# FOR JOBS LIKE THIS

Letters and figures on this plastic dial (for electric refrigerator temperature control) were included in the mold. This resulted in a substantial saving over the cost of machining them into the piece, after molding.

Such a method might seem to be simple and obvious, but it required much special skill. The correct plastic compound with the proper shrinkage had to be chosen. Then, the molds had to be designed so that the pieces could be removed without defacing the markings.

This special "know-how" is what we at General Industries offer you in our molded plastics division. Of course, we have all the machinery needed for large or small jobs in compression, transfer or injection molding. But in addition, we have that ingenuity, skill in mold making and willingness and ability to think through on a job before it is undertaken. In plastics molding, there is no substitute for experience.

If your postwar products call for plastic parts, we suggest you consult us before making definite commitments. While our engineers and facilities are now taxed to the limit with war work, we can discuss your requirements in general terms, and later get down to facts and figures. We'd like to work with you.

ARMY E NAVY

THE GENERAL INDUSTRIES COMPANY

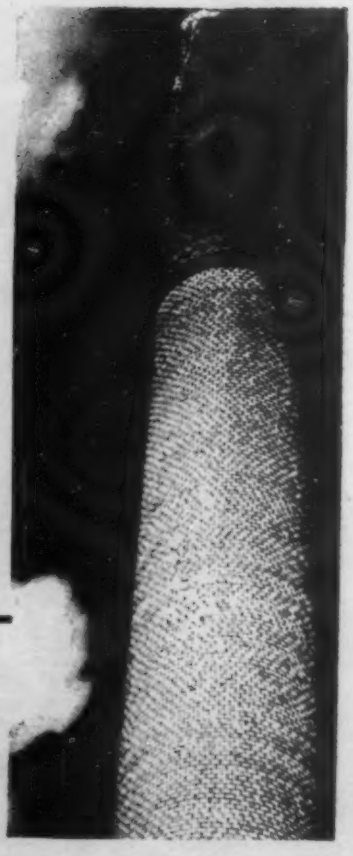
MOLDED PLASTICS

*Molded Plastics Division • Elyria, Ohio*

Chicago: Phone Central 8431
Milwaukee: Phone Daly 6818
Detroit: Phone Madison 2146
Philadelphia: Phone Camden 2215


Airplane plants will switch to automotives . . . radar factories will turn to radio . . . bomb manufacturers will convert to electrical appliances, baby carriages, etc. And so it will go! ★ For how many of these potential new applications of Plastics can you furnish essential information on the Plastics you manufacture? Suppose it's a question of impact strength, or flammability, or dielectric strength, or insulation resistance, or a hundred other points concerning the physical, electrical or chemical properties of your Plastics? ★ Progressive Plastics manufacturers, looking to the future, are employing Scientific Testing to give them the facts about their products. At our laboratories, Plastics are tested for chemical, electrical or physical properties and for problems of practical application to a specific manufacturing requirement. ★ Be forearmed with facts . . . write for a complete price list covering Scientific Tests.

*Member of American Council of Commercial Laboratories*



**THE UNITED STATES TESTING COMPANY, INC.**

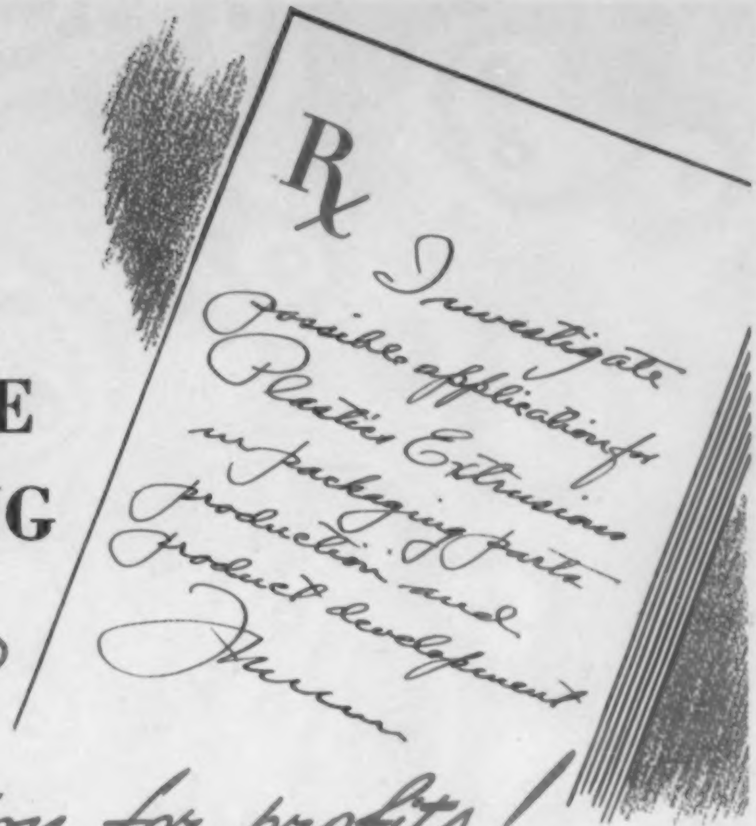
ESTABLISHED 1880

HOBOKEN, NEW JERSEY

PHILADELPHIA, PA • BOSTON, MASS. • WOONSOCKET, R. I • CHICAGO, ILL. • NEW YORK, N. Y


CMP
FRAMEWORK FOR THOUGHT
This exquisite mirror frame, injection processed of crystal clear methyl-methacrylate symbolizes tomorrow... the tomorrow when simultaneously upon receipt of Victory's last citation, "Well Done, Plastics," the industry will have also received its first command of Peace: "Serve Beauty and Utility . . . their plastics needs are many" . . . AND since a part of Consolidated's planning and developing facilities is now devoted to thinking ahead with and planning for plastics-minded product manufacturers, an early get-together is suggested. Inquiries invited.
Consolidated
MOLDED PRODUCTS CORPORATION
309 CHERRY STREET, SCRANTON 2, PA.
NEW YORK ........ 1790 Broadway
BRIDGEPORT ........ Rock Ridge Drive
CLEVELAND ........ 5713 Euclid Ave.
DETROIT ........ 550 Maccabees Bldg.
CHICAGO ........ 459 West Randolph St.

# A MEDICAL SUPPLY HOUSE THAT'S WRITING ITSELF




## a prescription for profits!

WHEN a medical supply company wrote to us for further information on plastics extruders, we probably shouldn't have wondered why. For almost all business can benefit in some way by utilizing the many advantages of the modern process of extruding plastics.

So it's reasonable to suppose that there's a place in your *manufacturing methods* where extruded plastics would simplify fabrication, save time, labor and money. Or your *marketing* might be improved by a more attractive, more economical extruded plastics container. Perhaps extruded plastics parts could be used to improve *product design* and *performance.*

So we suggest this: *Look* for the hidden possibilities for plastics extrusions in your business. Think of *your* products in terms of this continuous, simplified production method that can bring you added profits through added sales appeal. Then, for further information on plastics extrusions write to America's leading manufacturer of plastics extrusion machinery.

**Why Not Extruded Plastics For Display Shelving?**

Properly compounded and designed, display shelving of extruded plastics sections should have all the required physical properties, and pay a real bonus in eye-appeal, cleanliness, and ease of installation.

**Plastics Division**

EXTRUSION MACHINERY

NATIONAL RUBBER MACHINERY COMPANY

General Offices: Akron 11, Ohio


# *Intricate Molding Problems Solved!*

★

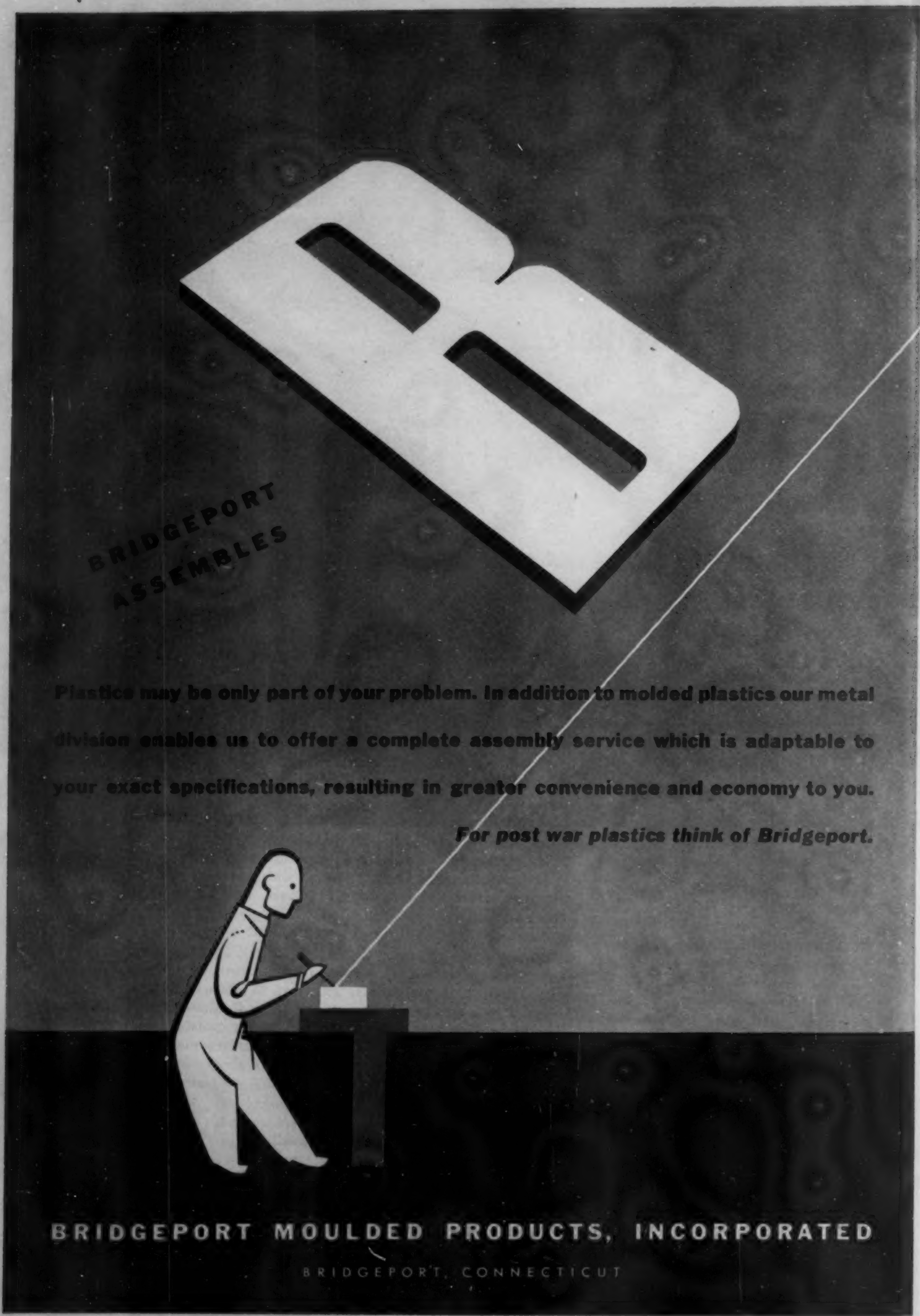
● The secret of successful plastic molding lies largely in the molds. Often an intricate job like the one pictured here, requires true genius together with skill that only long plastic experience can give. Here again, a problem that had long defied solution was completely overcome by our resourceful engineers. The design and construction of this mold permits production of a worm assembly without vertical, frictional parting line!

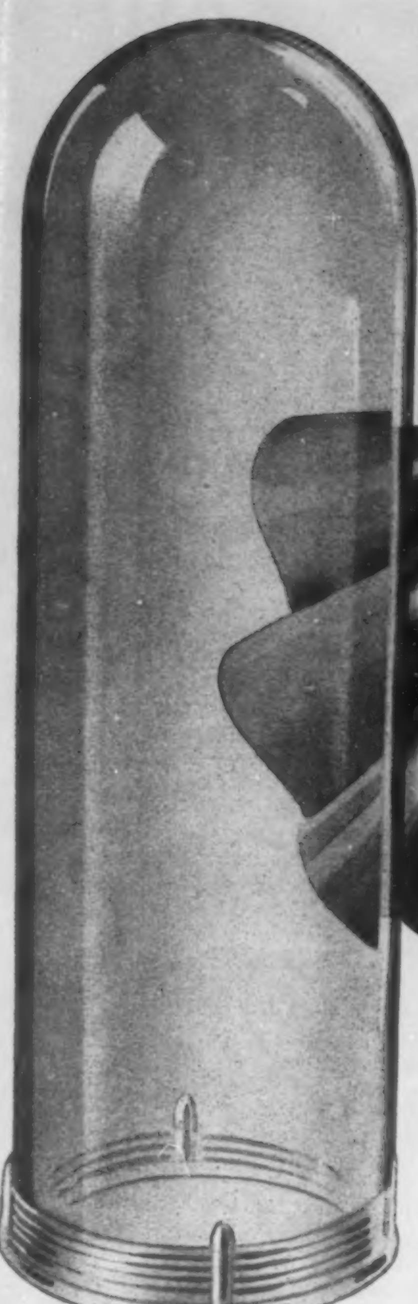
Examination of pre-war plastics competitions reveals a number of winners to our credit. Some of these represented intricate metal reinforced moldings . . the first or the biggest of their kind ever produced by speedy, economical injection molding. If you are planning a post-war product or part that may be better produced in plastics entrust it to SANTAY craftsmen. May we give you suggestions, ideas, cost estimates? You *could* write today!

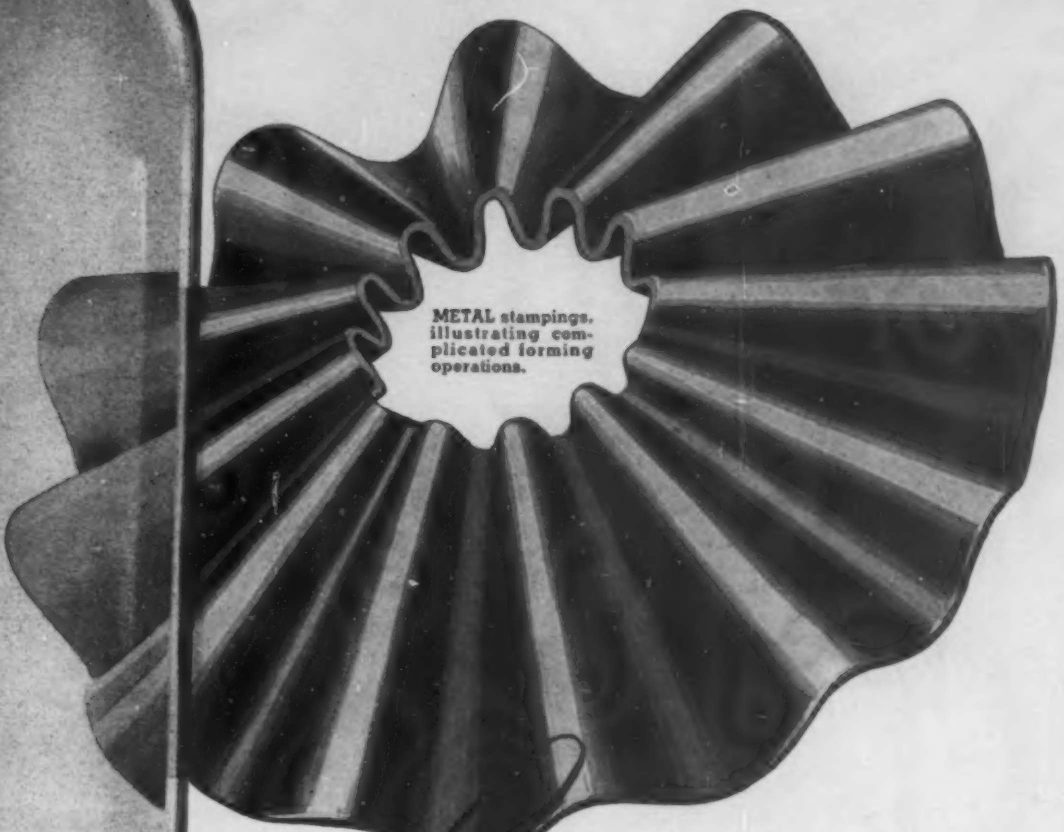
**SANTAY CORPORATION 351-359 N. CRAWFORD AVE., CHICAGO 24, ILLINOIS**

FORMERLY SINKO TOOL & MANUFACTURING CO.

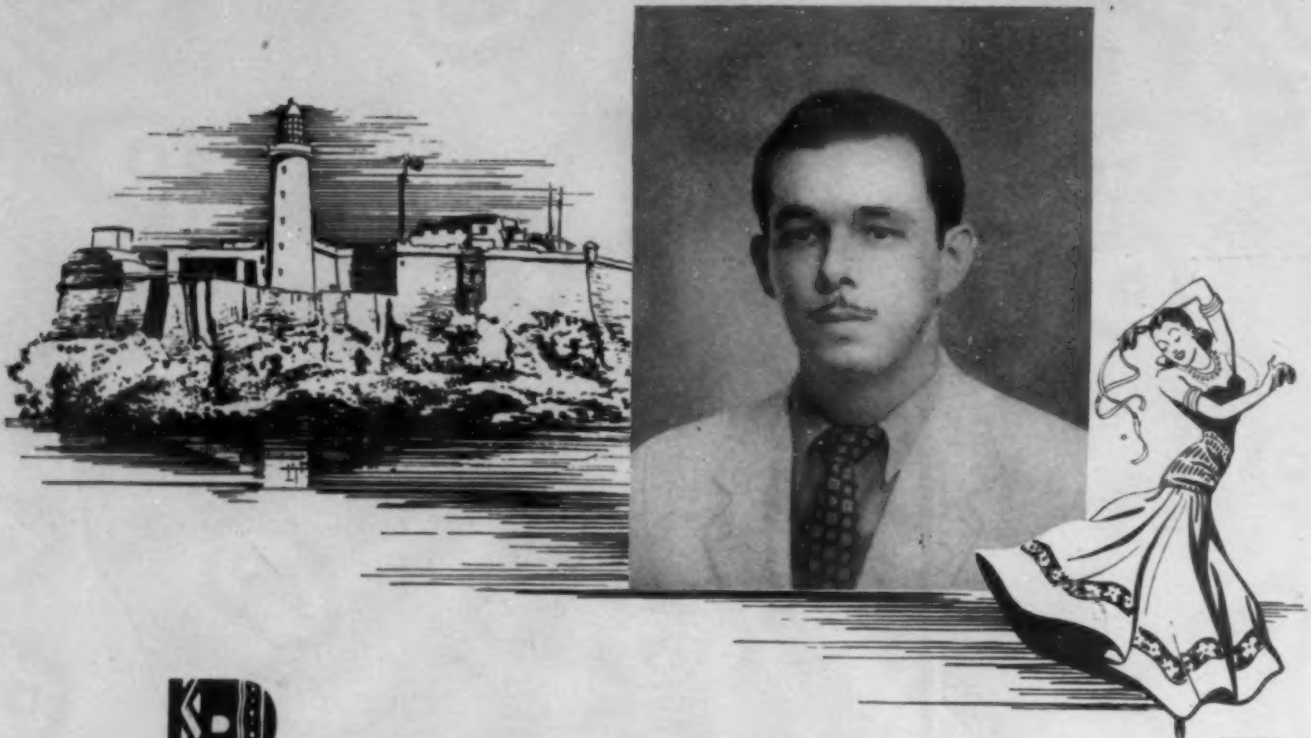
**REPRESENTATIVES:** POTTER & DUGAN, INC., 29 WILKESON STREET, BUFFALO 2, NEW YORK • PAUL SEILER, 7779 CORTLAND AVENUE, DETROIT 4, MICHIGAN • QUEISSER BROS., 108 E. NINTH STREET, INDIANAPOLIS 2, INDIANA


BRIDGEPORT
ASSEMBLES
Plastics may be only part of your problem. In addition to molded plastics our metal division enables us to offer a complete assembly service which is adaptable to your exact specifications, resulting in greater convenience and economy to you.
For post war plastics think of Bridgeport.
BRIDGEPORT MOULDED PRODUCTS, INCORPORATED
BRIDGEPORT, CONNECTICUT





METAL stampings, illustrating complicated forming operations.



# PLASTICOS CUBANOS, S. A.

There were no custom plastics molders in Cuba when Victor J. Rodriguez of Havana enrolled at Plastics Industries Technical Institute. However, upon graduating from the Institute, senor Rodriguez organized Plasticos Cubanos, S. A., which has since developed into a thriving custom molding business under his able direction. Of this training he writes:

> "I need not tell you how helpful the Institute course has been in making me understand and appreciate the many possibilities of the fascinating field of plastics, even in countries that do not have large markets within their boundaries. I will always be thankful to the Institute staff and methods for teaching me how to think in plastics."

Thus, in still another part of the world Plastics Institute has helped to further the use of plastics.

Perhaps you or someone you know is interested in obtaining this practical, reliable plastics instruction. Your inquiries regarding our resident and home study courses are invited.

**ADVISORY BOARD**

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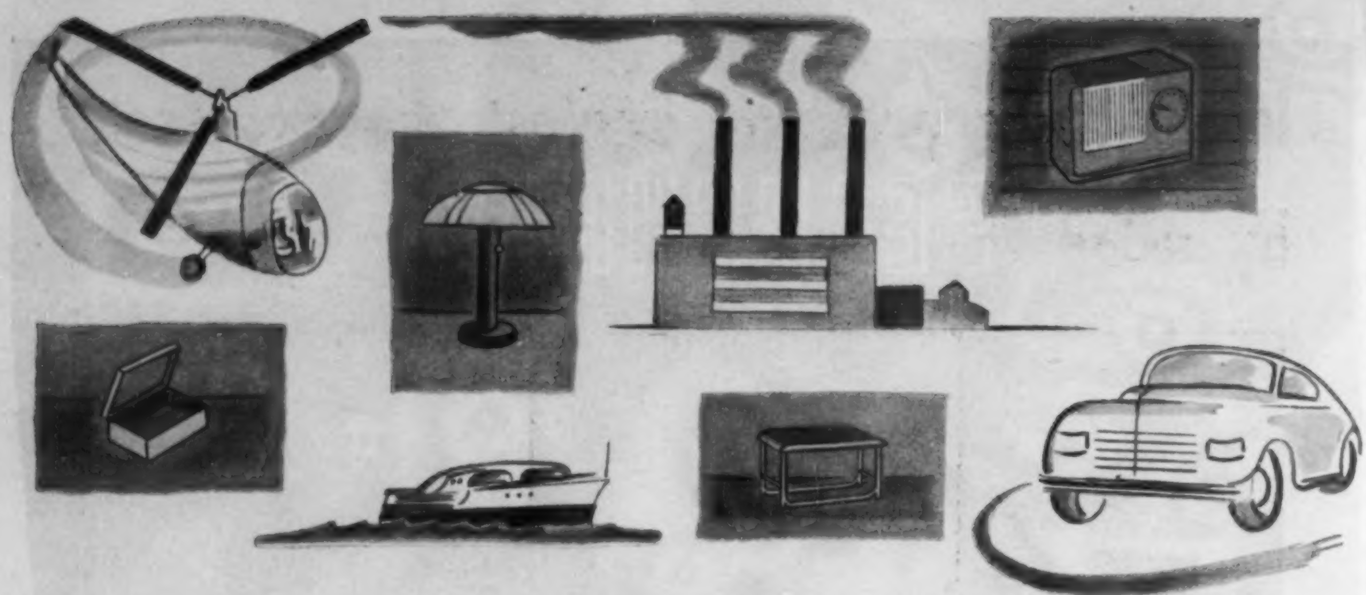
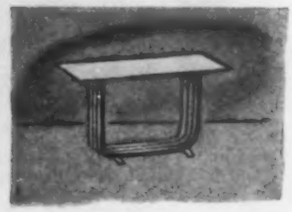


# come to dura →→→→→→ with your ideas



## FOR POSTWAR PLASTIC FABRICATING

In the world to come, new products will be necessary to satisfy the public's demand for color, vitality, comfort and convenience.

Our facilities and experience, now entirely devoted to war production to help bring peace sooner, will be at your disposal to plan and produce new things to make this a better world. The problems met by **dura** today in building vital parts for our landing craft, planes, and armored cars foretell the achievement **dura** will make in peacetime production.

Now is the time to consult us on your postwar plans. Any plastic fabricating problem of yours becomes our challenge to help you solve and overcome.

CONSULT DURA FIRST

**dura plastics,** inc. 1 WEST 34 STREET, NEW YORK 1, N. Y.

*Custom fabricating specialists to the aviation, electronic and shipbuilding industries.*

## We're READY and SET for the GO Signal

When wartime restrictions are lifted and industry is given the GO signal, Stokes will enter its third post-war period equipped with extensive manufacturing and research facilities to meet the demands of civilian production.

Since 1897, through the post-war periods following the Spanish-American War and World War I, Stokes has worked hand in hand with American Industry in the development of hard rubber and plastic products. This experience is at your disposal in formulating present plans for the future.

# JOS. STOKES RUBBER CO.

**Molders of Hard Rubber and Plastics • *Since 1897***

**TRENTON, N. J.**

In Canada: Jos. **STOKES RUBBER** Co., Ltd., WELLAND, ONT.


DILECTO parts, like those illustrated, are used throughout communications systems, detecting devices and controls wherever electrical currents must be insulated. DILECTO electrical insulating parts must function satisfactorily regardless of humidity, dryness, vibration, concussion. They must be mechanically strong . . . resistant to moisture and temperature . . . and dielectrically effective. In all these requirements DILECTO excels.

DILECTO is also readily fabricated. It may be machined, punched, drilled, tapped, and even formed. It is made in many grades . . . each engineered to meet specific electrical or mechanical problems. DILECTO may be the answer to your "WHAT MATERIAL?" problem. Send for catalog "DO" which gives complete technical and physical data.

KB-44

## C-D PRODUCTS

**The Plastics**
DILECTO—A Laminated Phenolic.
CELORON—A Molded Phenolic.
DILECTENE—A Pure Resin Plastic Especially Suited to U-H-F Insulation.
HAVEG—Plastic Chemical Equipment, Pipe, Valves and Fittings.

**The NON-Metallics**
DIAMOND Vulcanized FIBRE
VULCOID—Resin Impregnated Vulcanized Fibre.

MICABOND—Built-Up Mica Electrical Insulation.

**Standard and Special Forms**
Available in Standard Sheets, Rods and Tubes; and Parts Fabricated, Formed or Molded to Specifications.

**Descriptive Literature**
Bulletin GF gives Comprehensive Data on all C-D Products. Individual Catalogs are also Available.

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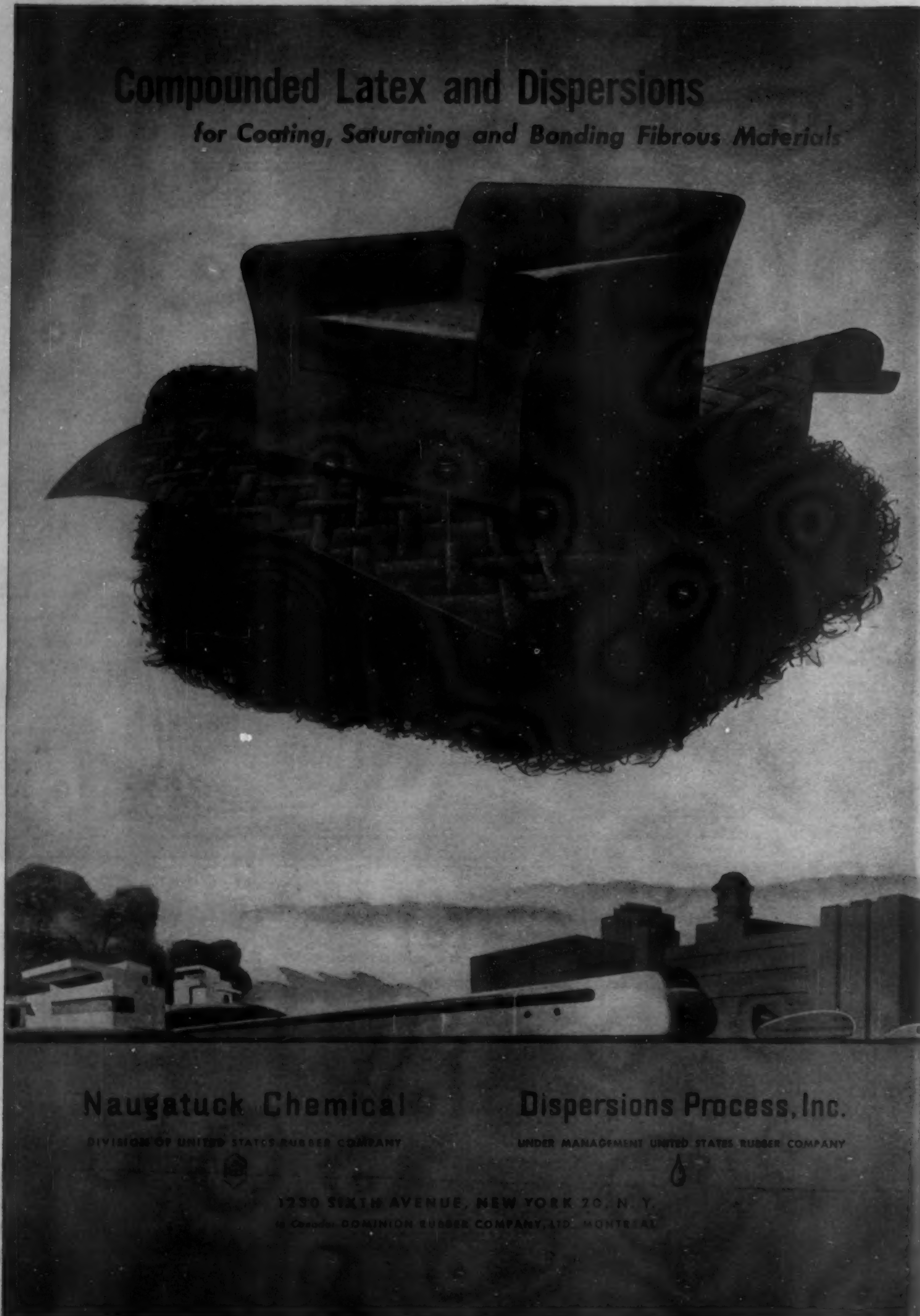
**Continental-Diamond** FIBRE COMPANY

*Established 1895.. Manufacturers of Laminated Plastics since 1911*—NEWARK 28 • DELAWARE



Compounded Latex and Dispersions
for Coating, Saturating and Bonding Fibrous Materials
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DIVISION OF UNITED STATES RUBBER COMPANY
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UNDER MANAGEMENT UNITED STATES RUBBER COMPANY
1230 SIXTH AVENUE, NEW YORK 20, N. Y.
In Canada: DOMINION RUBBER COMPANY, LTD. MONTREAL

# How to make the best use of plastics

**WAFFLE IRONS**
handles—Resinox, Resimene
plugs—Resinox, Resimene

**TELEPHONES**
housing—Resinox, Resimene
buttons—Lustron, Fibestos
coil forms—Cerex, Fibestos, Resinox

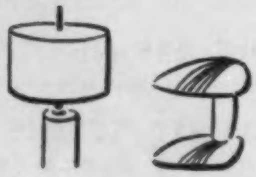
**GRILLS**
handles—Resinox, Resimene
bases—Resinox, Resimene

**IRONS**
handles—Resinox, Resimene
switches, plugs—Resinox, Resimene

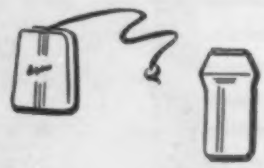
**MIXERS**
handles, controls—Resimene, Cerex
bowls—Lustron, Cerex
housing, base—molded of laminated Resinox, Resimene

**VACUUM CLEANERS**
housing, parts—Resinox, Resimene
handle—Resinox adhesive in spiral wound tube

**CHIMES**
molded housings—Resinox, Resimene, Lustron, Fibestos



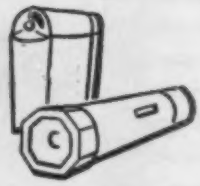
**LAMPS**
shades—Fibestos sheets
molded parts—Lustron, Resinox, Resimene, Cerex



**HEARING AIDS**
housing, parts—Resinox, Resimene

**SHAVERS**
housing—Resinox, Resimene, Lustron

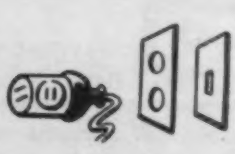
**THERMOSTATS**
housing—Resinox, Resimene
crystals—Lustron, Fibestos



**FLASH LIGHTS**
housings—Resinox, Fibestos
crystals—Fibestos, Lustron

**COFFEE MAKERS**
covers, handles, bases—Resinox, Resimene
bowls—Cerex

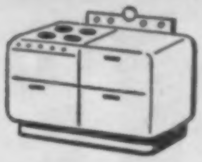
**LIGHTING FIXTURES**
end caps—Lustron, Cerex
diffusion panels—embossed Fibestos sheets, molded Lustron, Cerex



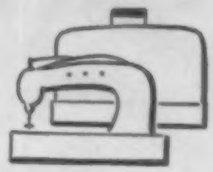
**SWITCH PLATES, ETC.**
push buttons, sockets, plates—Resimene, Lustron, Resinox, Fibestos, Cerex

# in postwar ELECTRICAL APPLIANCES

**TOASTERS**
handles — Resinox, Resimene
bases — Resinox, Resimene

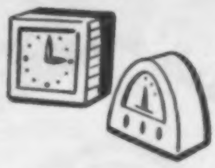


**RANGES**
handles, controls — Resinox, Resimene
clock housing — Resinox, Resimene
clock crystal — Fibestos, Lustron
laminated kick plate — Resimene, Resinox



**SEWING MACHINES**
housing, parts — Resinox, Resimene

**IRONERS**
controls, handles — Resinox, Cerex
base — laminated Resimene



**CLOCKS, TIMERS**
crystals — Fibestos, Lustron
knobs, housings — Resinox, Resimene, Lustron, Cerex

**FANS**
blades — transparent, flexible Monsanto vinyl acetal
housing, controls — Resinox, Resimene

## MONSANTO PLASTICS FOR ELECTRICAL APPLIANCES

| | Tensile Strength | Impact Resistance | Heat Resistance | Dimensional Stability | Electrical Insulation | Color* Range | Forms* Supplied | Molding** Methods |
|---|---|---|---|---|---|---|---|---|
| **CEREX** (heat-resistant thermoplastics) | good | good | to 230°F. | excellent | excellent | extensive | MC | I, C, E |
| **FIBESTOS** (cellulose acetates) | good to excellent | excellent | to 120—212°F. | fair to good | good | unlimited | MC, S, R, T | I, C, E |
| **LUSTRON** (polystyrene) | good | good | to 180°F. | excellent | excellent | unlimited | MC | I, C, E |
| **NITRON** (cellulose nitrates) | very good | excellent | to 140°F. | good | fair | unlimited | S, R, T | Special methods |
| **RESIMENE** (melamine-formaldehydes) | very good to excellent | good | to 210—380°F. | excellent | excellent | all but lightest colors | MC, IR | C, T |
| **RESINOX** (phenol-formaldehydes) | good to very good | good to excellent | to 230—450°F. | excellent | good to excellent | limited range | MC, IR | C, T |
| **VINYL ACETALS** | rubber-like compounds are supplied in both thermoplastic and thermosetting (vulcanizable) forms, are used primarily as fabric coatings and adhesives but can also be extruded in limitless range of colors. | | | | | | | |

*MC—molding compounds S—sheets R—rods T—tubes IR—industrial resins
**I—injection C—compression E—extrusion T—transfer, form of compression

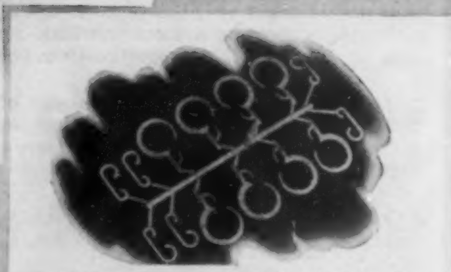
THESE two charts give you some indication of the breadth and versatility of the Family of Monsanto Plastics. They also illustrate one of the best reasons why it pays to include a Monsanto consultant early in your planning sessions: *he can give you disinterested advice on the largest, most varied group of plastics supplied by any one manufacturer.* For his help on your problems, write: MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield 2, Massachusetts.

MONSANTO PLASTICS
SERVING INDUSTRY...WHICH SERVES MANKIND


INJECTION MOULDING
EXTRUSION MOULDING
PLASTICS
St. Louis
Plastic Parts of Every Description
ST. LOUIS PLASTIC
MOULDING COMPANY
SAINT LOUIS
MISSOURI
DIES AND TOOLS
PLASTIC FABRICATION
PIPE SARAN TUBING
MOULDED PARTS
NATIONAL

# *Could you Mill this 14 Cavity Mold complete in 52 Hours?*

*Close-up view of cavities in the solid mold block.*



*Plastic shower-curtain hooks in multiple, as they come from the mold.*

Photos — Courtesy The Kampa Manufacturing Co.

1000-P

This 14-cavity plastic mold is a "sticker" if you try to produce it by ordinary methods — but read this report of its production with the Milwaukee Rotary Head Milling Machine!

The Milwaukee Rotary Head method made it possible to set up both halves of this shower curtain hook mold on the machine table. One cavity of each shape was then laid out by means of a scriber held in the machine spindle. Each milling operation was first performed on the location of the layout and then repeated for each additional cavity. Uniform and unvarying precision is repeated by this multiple origination of cavities with the Rotary Head Method. Total milling time complete — 52 hours.

*Write for Bulletin 1002-C for full information on this unusual machine tool and the Rotary Head method of milling.*

BUILDERS OF MILWAUKEE ROTARY HEAD MILLING MACHINE • MIDGET MILL • SPEEDMILL • FACE MILL GRINDER • AUTOMATIC JIG BORER • CENTER SCOPE.

**Kearney & Trecker**
*Products*
**CORPORATION**
**Milwaukee 14, Wisconsin**

**Subsidiary of Kearney & Trecker Corporation**

CALENDERS
FOR LABORATORY TESTING
The 8" x 16" self-contained, four-roll calender (top) is designed primarily for laboratory use but is suited also to small production. A special feature is the flood lubrication of the journal boxes, with circulating pump, oil cooler and oil sump tank mounted in the base. A 4/1 adjustable-speed, explosion-proof motor provides the most efficient operating speed for any individual stock.
FOR FACTORY PRODUCTION
The 24" x 66" four-roll calender (lower), specially designed for sheeting and coating plastics, is a typical example of the "designed-for-the-job" calenders we have been building for the rubber and plastics industries for many years. Available in sizes up to 28" x 84", these calenders can be made with any number and arrangement of rolls and fitted with the necessary attachments to suit their particular function.
Write for further information regarding calenders or any of the other types of equipment listed on this page.
F-B PLASTICS MACHINERY
Banbury Internal Mixers
Roll Mills
Converting, Mixing and Sheeting Rolls
Calenders
Extruding Machines
Hydraulic Presses
Hydraulic Accumulators
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FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.
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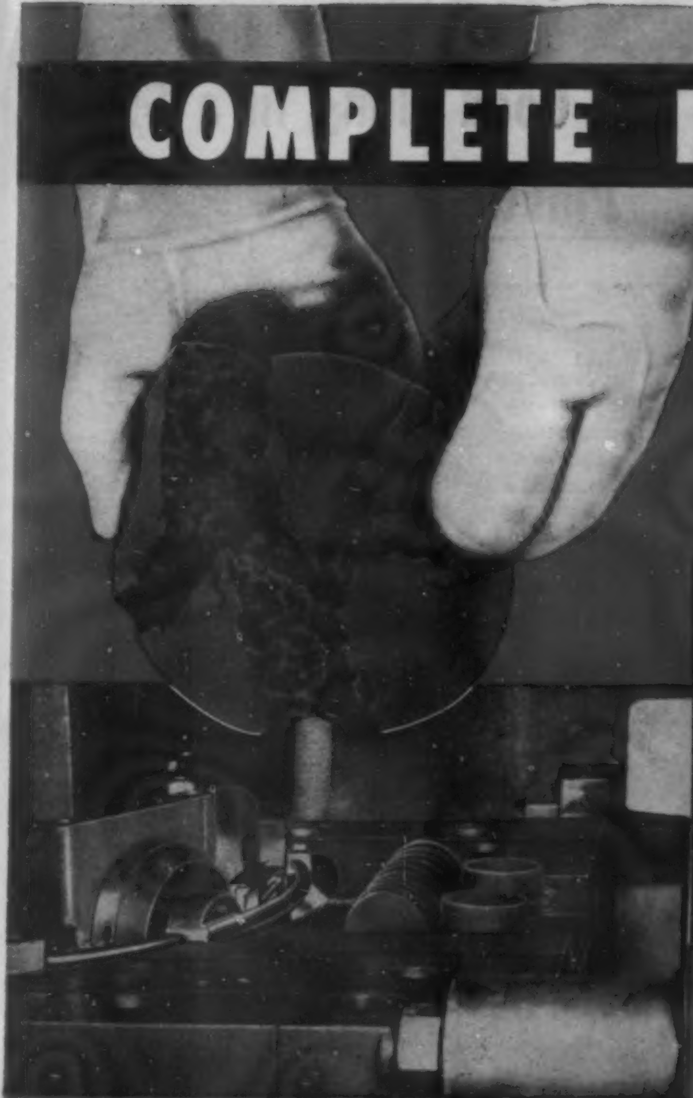
Farrel-Birmingham

# COMPLETE PLASTICITY!

## -MEGATHERM-*

## CUTS MOLDING TIME 90%



▲ *The molded handset ready for ejection from the mold after the 30 second perfect cure.*

◀ *Megatherm heated preforms in press transfer chamber just before closing.*
Photos Courtesy Shaw Insulator Co.

Federal Industrial Power Tubes, give power and performance to Megatherm and other industrial heating equipment.

Molding time on these telephone handsets was reduced from five minutes to 30 seconds with Megatherm.

In addition to rapid molding Megatherm provided a complete and uniform cure which was free of all internal stress.

Megatherm is doing plastic preform heating *better* and *more quickly* than any other method. In many cases Megatherm has made a plastic molding job possible which could not be done by other methods.

Megatherm units are compact, and may be easily moved from one production line to another. One of the four standard models will fit your production needs. Megatherm is available in 3 KW, 7 KW, 15 KW and 25 KW output capacities.

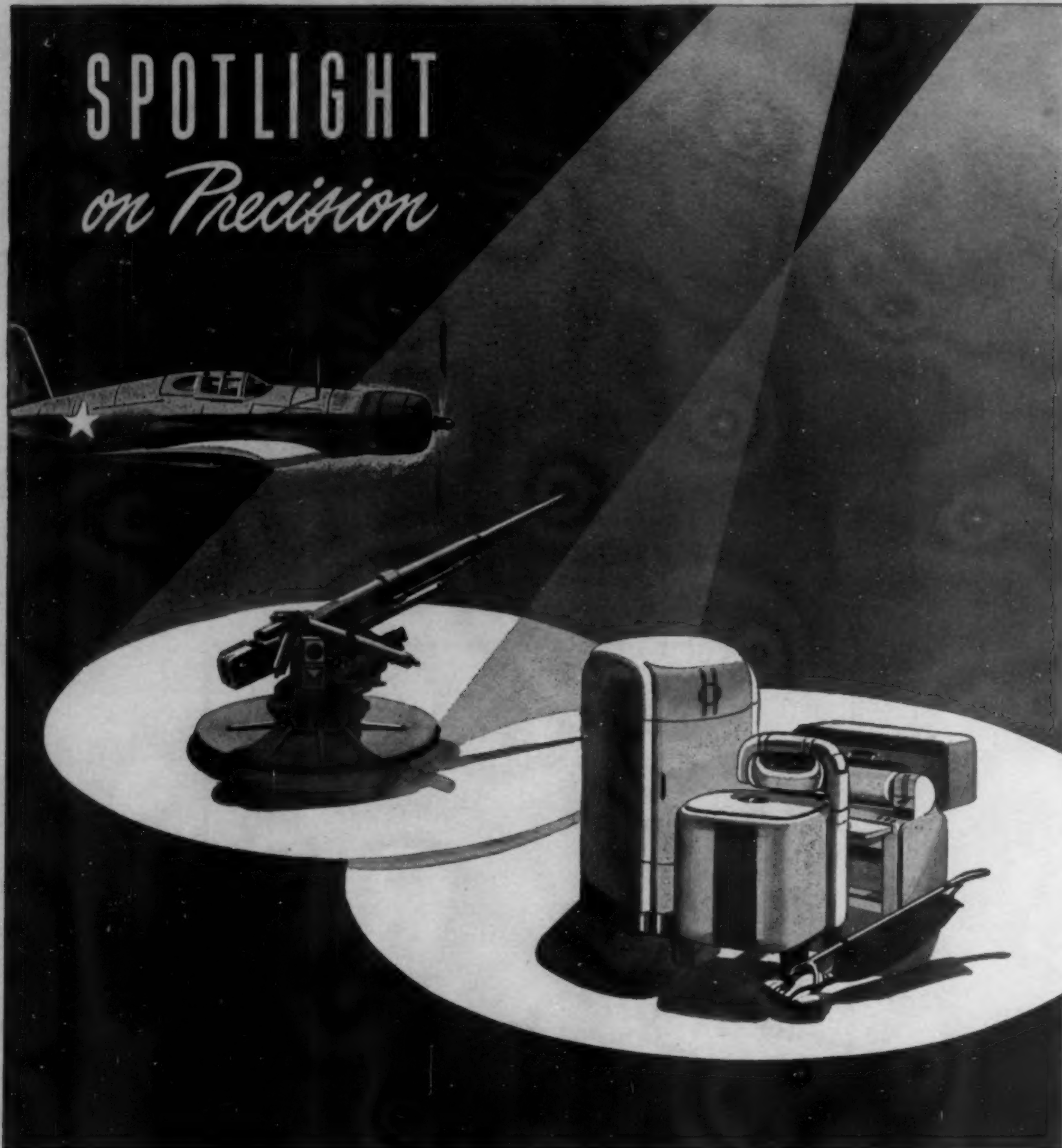
Cost of operation is low, the popular 3 KW Megatherm has a power cost of 5¢ per hour.

If you have a plastic preheating problem, now is the time to talk about it with Federal.

*Federal Telephone and Radio Corporation*
INDUSTRIAL ELECTRONICS DIVISION Newark 1, N. J.

AN IT&T ASSOCIATE

*REG. U. S. PAT. OFF.




*Buy More War Bonds*

Spotlighted in today's war production program are the hardened and precision ground parts made ***in great volume*** by Allied Products Corporation. Some of these parts, which are being made for top-flight aircraft engines, guns and other matériel of war, are finished to within limits of two ten-thousandths of an inch.

Projected into the postwar period, the facilities which have made possible Allied's wartime accomplishments will provide a deep reservoir of craftmanship, mass production machinery, and practical experience for manufacturers of consumer goods.

If you are planning a postwar product, and are looking for a dependable, economical source of tools and hardened and precision ground parts, get in touch with Allied Products Corporation now.

***"IT'S AN ALLIED PRODUCT"*** . . . Allied Products Corporation and its divisions, Richard Brothers and Victor-Peninsular, in Detroit and Hillsdale, Michigan, also make: Sheet metal dies, from the largest to the smallest; steam-heated plastic molds; jigs and fixtures, the original R-B Interchangeable Punch and Die; cap screws; cold forged parts; and other products.

# ALLIED PRODUCTS
## C O R P O R A T I O N

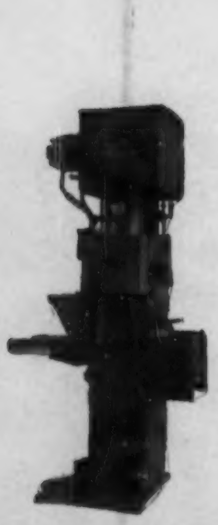
**Executive Offices: 4646 Lawton Ave., Detroit 8, Michigan**

***All Four Plants Have Added Stars To Their Army-Navy "E" Pennants***

# Select your molding equipment from this COMPLETE LINE

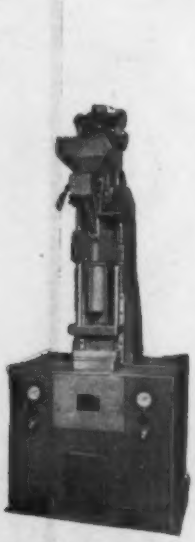
NO matter what plastic products you want to mold—what materials you want to use—you can get the right machine for any molding job from Watson-Stillman . . . builders of the most complete line of hydraulic equipment available for compression and injection molding on large scale production, diversified short runs or in the laboratory. All Watson-Stillman equipment embodies operating and production features consistent with latest trends in plastic materials and molding techniques.

In the W-S experimental laboratory plastic specialists and hydraulic engineers test machines, materials and dies under actual production conditions. At Watson-Stillman you can get—without obligation—unbiased advice on selecting equipment and on other molding problems, based on intimate association with the Plastics Industry from its very beginning. Write or call the Watson-Stillman Company, Roselle, New Jersey.

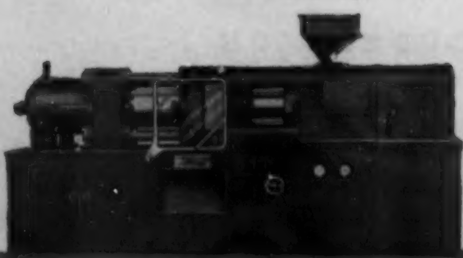


AUTOMATIC COMPRESSION MOLDING MACHINES 25-75 TONS

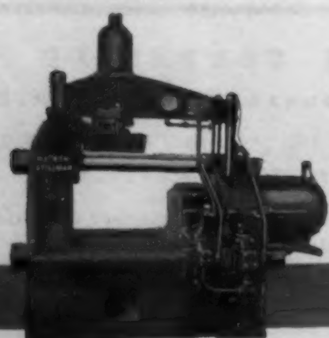
SEMI-AUTOMATIC COMPRESSION MOLDING MACHINES 50-850 TONS



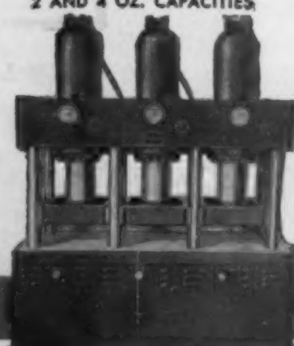
VERTICAL INJECTION MOLDING MACHINES 2 AND 4 OZ. CAPACITIES



HORIZONTAL INJECTION MOLDING MACHINES 6 TO 24 OZ. CAPACITIES



ANGLE MOLDING PRESSES



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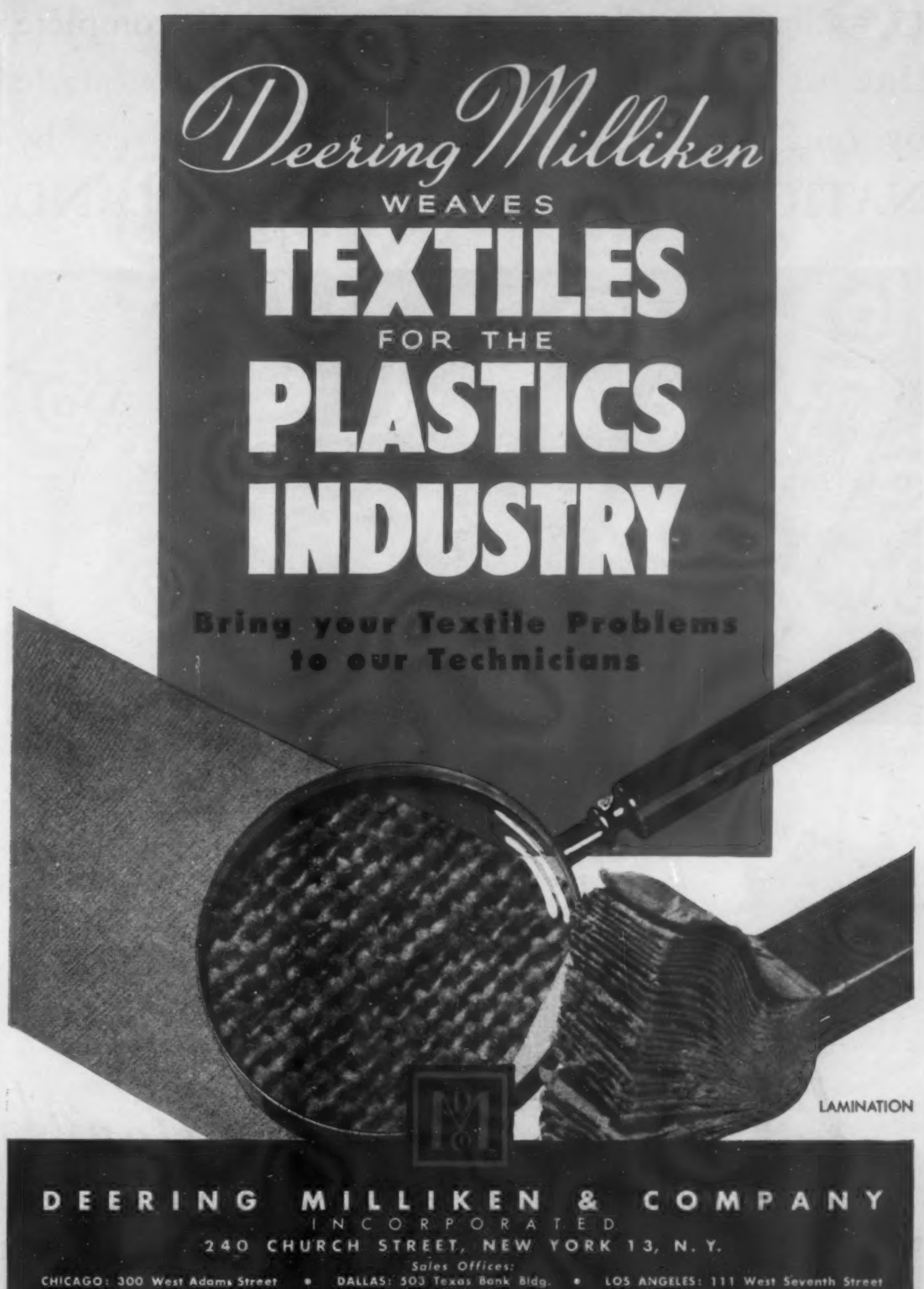
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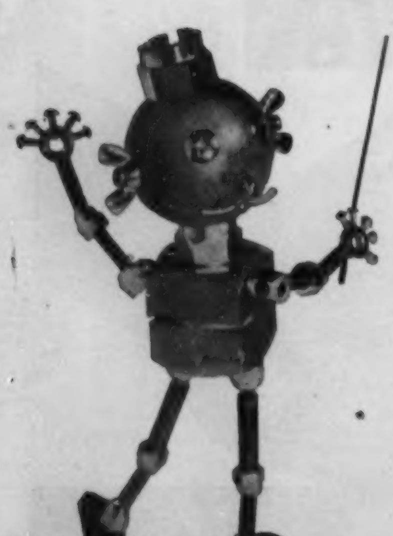

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MODERN PLASTICS

NOVEMBER 1944 VOLUME 22 NUMBER 3

# Industry expansion

AMERICAN manufacturers, absorbed as they are with production of armament, are also laying plans for peacetime manufacture of their own lines—plans that must necessarily depend upon their ability to get delivery of component parts. Those who have used plastics in the past, together with a large number who expect to use them for the first time in their postwar products are eager, therefore, to know the capacity of the plastics industry to handle the volume of orders that will accompany resumption of civilian production. Even more concerned with the panorama of the future than these end users of millions of plastic parts are the members of the industry itself. This article attempts to answer the various questions which have arisen in the minds of both these groups.

INDIVIDUAL molders, laminators and extruders may know quite definitely the trend of their postwar operations and, without doubt, trade confidences among themselves. But one man's guess is as good as another's in projecting an over-all picture of the industry when peace brings a resumption of normal trade practices and the leveling influences of competition. Some believe that the industry will be greatly expanded by an influx of new molders attracted to the field by popular enthusiasm of the glamor variety. The ideas of others are based upon rumors that many users of large quantities of plastic parts are planning to do their own molding.

To answer the questions both of the industry itself and of the end users of its products, MODERN PLASTICS set out to make a survey which was conducted by means of personal interviews plus a questionnaire mailed to 500 molders, extruders and laminators who constitute the bulk of the industry. The questionnaire asked seven basic questions designed to show the present capacity of the industry, its growth during 1943, new production methods employed, new equipment ordered but not yet installed, monthly consumption of materials and plans for plant expansion. Producers of raw materials and machinery manufacturers were consulted about their postwar plans.

It should be understood from the outset that this survey is devoted exclusively to materials and machines used in compression, transfer and injection molding, high-pressure laminating and extrusion. It is not practical at this time to attempt a survey on low-pressure or post-forming laminates. In the extrusion field, wire coating will be handled separately from other extruded plastic products. Other branches such as fabricating, coatings, cast resins, casting resins, abrasive wheels, brake linings (specialties), flexible films, adhesive resins, cold molding, shellac compounds, textiles and textile treatment other than those used in laminates are eliminated from consideration unless specifically mentioned. Thus, although it will cover what the layman generally classifies as the "plastics industry"—namely, molding and laminating—it will in reality concern itself with what is estimated to be less than 40 percent of all production that might be credited to the industry in its entirety.

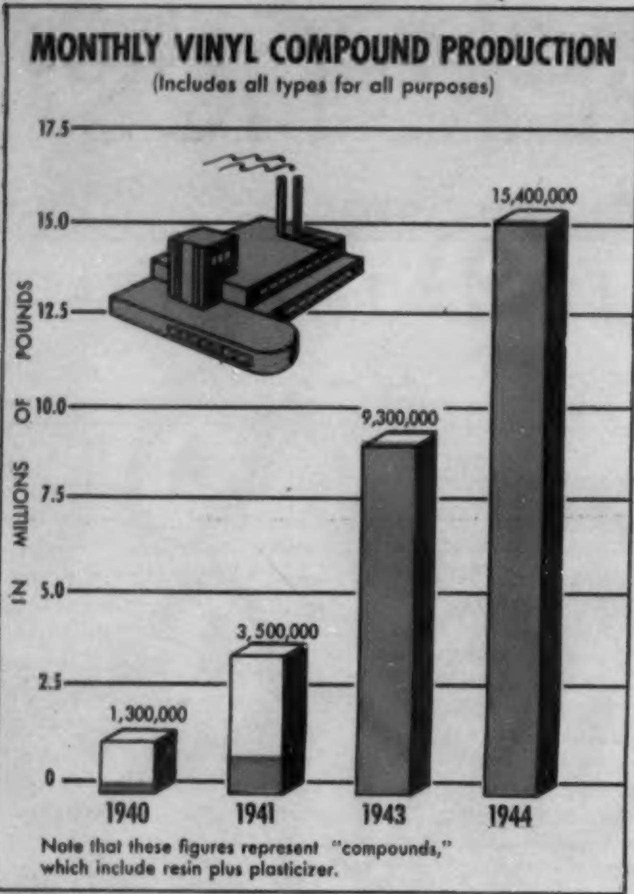
It was necessary, of course, to compare the figures received from the companies questioned with statistics of authentic correctness in order to determine whether these figures represented conditions in a true cross section of the industry. In all instances where doubt arose, the data were subjected to still further scrutiny until the bugs commonly encountered in research and survey practice had been eliminated. Additional checks were made with molders to determine factual data on such figures as "rate of production from specific equipment," machinery manufacturers were questioned on their production and sales of equipment, and all statistics were finally submitted for review to men long familiar with the characteristics and intricacies of the industry.

That the plastics industry has performed its wartime assignment amazingly well is not news either to the industry itself or to the procurement departments of the several branches of the Armed Services which have worked so diligently to utilize the potentialities of plastic materials. Nor are the industry's customers—the prime contractors and sub-contractors for materiel of war—lacking in appreciation of the manner in which it has responded to the calls made upon it. Statistics can only suggest the behind-the-scenes drama which accompanied each new assignment given the industry—assignments which, of course, rapidly accelerated production.

### Before Pearl Harbor

In the year 1941, molders were turning out the millions of industrial parts which went into automobiles, radios, household appliances, et cetera. The injection presses were producing both small wares and intricately designed large pieces in quantities undreamed of even five years previously and at prices which were low, but profitable. The combination of new materials and advanced molding techniques was producing a wealth of plastic products, all designed for peacetime living. Few, if any, molders dreamed that M-52 fuzes, Browning automatic rifle gun butts, helmet liners, tank periscope lens holders, ammunition boxes, hand grenades, bomb racks for fighter planes, life raft equipment, bayonet scabbards, gas mask parts, foot tubes, snake bite kits and other plastic articles for war use would soon supplant civilian goods.

The industry had enjoyed a consistent growth—more spectacular, perhaps, than that of many others which it served—



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ALL CHARTS BY PICTOGRAPH CORP.

because its progress was the direct result of the rapid advances made in industrial chemistry and the wizardry of industrial machine design. In physical aspect it looked like this when the Japs sneaked in on Pearl Harbor: some 500 molders were operating approximately 9000 presses of which 8000 were compression and 1000 were injection. There are no authentic figures on machines used for plastic extrusion at that date because the process was just coming into its own. The average monthly consumption of plastic molding compounds was approximately 13,000,000 lb.—of which 82 percent was consumed in compression molding.

A survey made early in 1942 indicates that the industry was operating at the rate of 50 percent of its potential maximum[1] capacity, an average of 84 hr. per machine per week. Injection presses were busiest, operating at 53 percent of theoretical capacity; compression presses at 51 percent. Thus it is quite obvious that the industry was in a position almost to double its production by doubling its work week.

[1] Potential maximum based on a work week of 168 hours.

### From peace to war

The first six months of the war did not alter the above picture to any extent. The molding industry was in a transitory stage. Its wartime contribution was still in the blueprint state, or in the midst of retooling. Production from compression molding even showed a decline in June 1942. On the other hand, production of acetate and butyrate parts rose to new heights because facilities to produce more molding powder were made available. These two materials were quickly fitted into the demand for sorely needed military items and the civilian trade picked them up as replacements for many unobtainable raw materials. It was during this period that many civilian items of low essentiality rating crept into the plastics picture and established a foothold from which it was difficult to dislodge them when the molding powder was needed for important military applications during the year 1943. It is possible that the industry may suffer for several years from some of the plastic misapplications that were made during this period because of the distaste created in the minds of many buyers by articles that were either made of the wrong material or should never have been designed for plastics under any circumstances.

It was also during 1942 that the molding industry, like all others, began to suffer from manpower troubles and from inability to get satisfactory metal from which to build mold facilities. Among the materials men, conflicting problems in obtaining raw materials for the manufacture of molding powders were daily occurrences. By the end of the year, however, the allocation system was well on its way to complete operation; and although molders and laminators were not able to get all the material wanted, they were at least assured of a sufficient amount for war work and an orderly system whereby they could make fairly accurate estimates of what items they would be permitted to manufacture and how much material they could obtain to produce them.

Because 1942 was full of chaos and because statistics of that year mean little for the purposes of this survey, they are omitted from consideration in Table I and Fig. 1, which show the growth of molding powder production from 1940 through the third quarter of the current year. Powder used for extrusion purposes is also included in these figures because there are no obtainable statistics that would permit separate classification. Vinyls are separated from the other figures because, while not particularly vital to the molding industry at this time, they may soon come into the picture and, of course, are tremendously important in the extrusion field.

While figures used in this table and chart have been carefully compiled from various sources, they should not be taken as official nor absolutely accurate down to the last pound. The purpose is to show trends and every precaution

TABLE I.—MONTHLY PRODUCTION OF MOLDING POWDER IN POUNDS, 1940 TO SEPTEMBER 1944

| *Material* | *1940* | *1941* | *1943* | *1944* | *1944* |
|---|---|---|---|---|---|
| | | | | *Current production* | *Current capacity* |
| Phenolic | 6,600,000 | 9,000,000 | 10,000,000 | 10,000,000 | 12,000,000 |
| Urea and melamine | 1,500,000 | 2,000,000 | 3,000,000 | 3,000,000 | 3,500,000 |
| Acetate and butyrate | 1,300,000 | 2,000,000 | 5,500,000 | 5,500,000 | 5,500,000 |
| Ethyl cellulose, Polystyrene, Acrylic [a] | 250,000 | 450,000 | 750,000 | 850,000 | 2,000,000 |
| | 9,650,000 | 13,450,000 | 19,250,000 | 19,350,000 | 23,000,000 |

[a] For breakdown of these items see text, page 99 and following.

has been taken to remove all misleading factors. As far as we know, this is the first time that molding powder figures have actually been assembled on this broad scale. Manufacturers and Government statisticians commonly use synthetic resin figures without breaking them down into all the various categories, so that many items which have no connection with the molding industry are listed under the broad term "plastics." This would appear to be the principal reason why there are so many sets of statistics in the industry and why it is so difficult to reconcile them. It is only the allocation system that makes this segregation of molding powder figures possible, and it could be that after the emergency allocation system has passed into limbo many years will pass before statisticians find a satisfactory method for segregating raw material figures into their various categories.

### Molding powder production, 1940–44

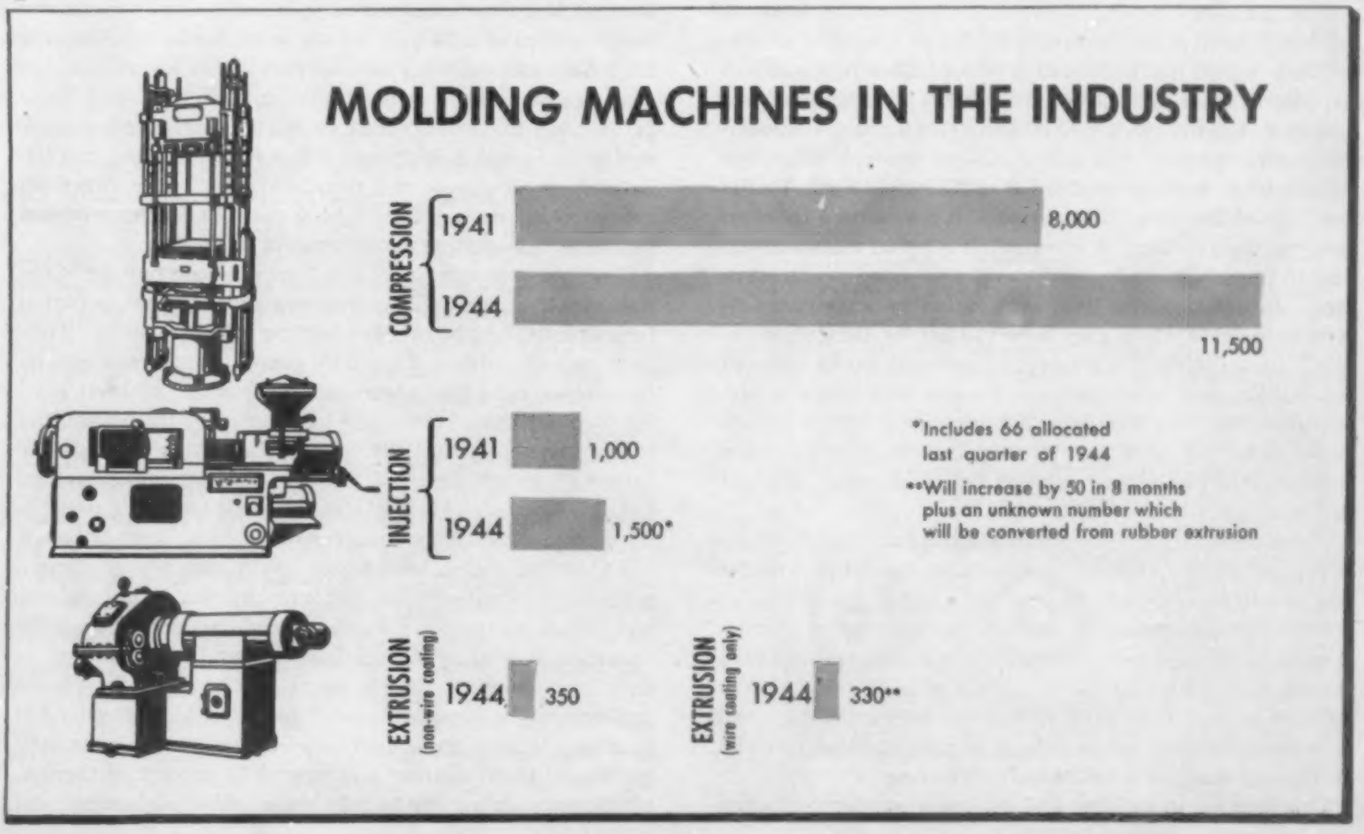
No one should use the figures in Table I and Fig. 1[2] without careful study and a realization that there are certain variable factors which it is impossible to eliminate. No one will guarantee, for example, that the "current capacity" figures are absolutely rock bottom since there is no positive measuring stick; but consensus of opinion leans to this final conclusion. Above all it must be emphasized again and again that these are molding and extrusion compounds only.

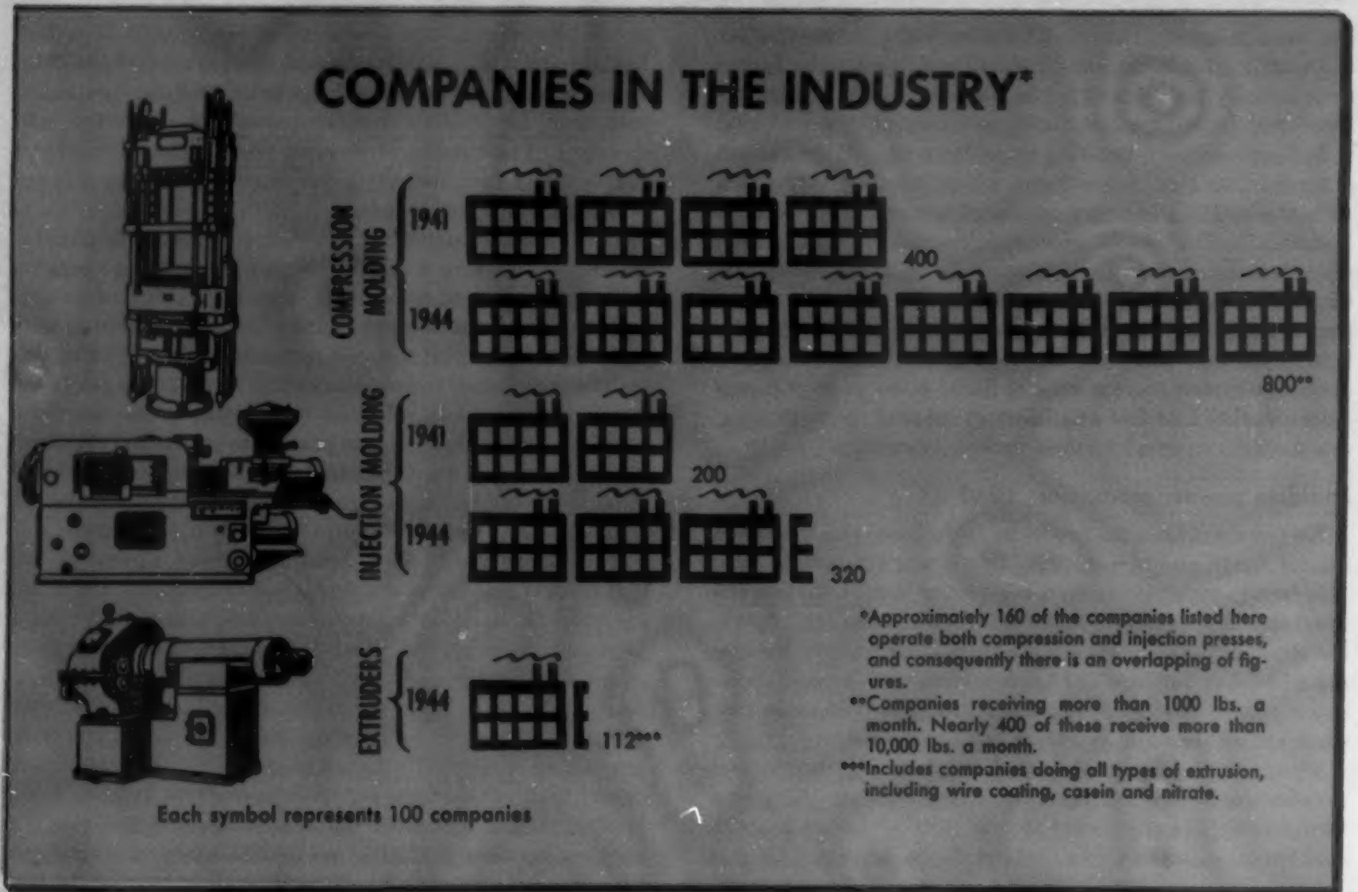
The combined figures for ethyl cellulose, polystyrene and acrylics need some explanation. Ethyl cellulose has grown from a meager production of around 1400 lb. of resin a month in 1940 to something like 700,000 lb. at present. Of this 700,000 lb., about 250,000 lb. is used for molding and extrusion powder. The balance goes largely into lacquers, adhesives, strippable protective coatings and film. Polystyrene monthly production has grown from around 150,000 lb. of molding powder in 1940 to something like 300,000 lb. today. The acrylics are more complicated than the others because figures are of necessity closely guarded and because resins once used for molding powder have been converted into sheeting. The amount of molding powder used monthly in 1940 was less than 100,000 lb. per month, but today it is approximately 300,000 pounds.

The last two columns in Table I deserve special interpretation. They involve a certain amount of "hedging" because neither Government nor private industry is going to divulge confidential figures in an emergency period, and even in normal times it is difficult to ascertain current figures of this type. On the other hand, the plastics industry is eager to get as accurate a picture as possible at this propitious moment just before partial reconversion to peacetime goods, and members have cooperated whole-heartedly in helping to make this study as nearly factual as possible. It seems safe to assume that any margin of error is insufficient to upset trends.

Turning to the column headed "current capacity," we find there is considerable difference of opinion over the figure for phenolic molding compounds. The industry has been producing highest grade compounds due to the exacting demands of the Armed Forces. Production has been slowed down due to these strict requirements and lack of manpower. In normal times manufacturers would turn out a greater proportion of general all-purpose phenolic compounds and thus speed up and increase their production totals. Some producers have estimated that the industry might possibly turn out between 15,000,000 and 20,000,000 lb. of all-purpose phenolic molding compounds monthly if they were to run exclusively on that type. But there isn't much likelihood that such a condition will exist in the foreseeable future. There will always be a sizable proportion of special purpose phenolics. A composite view of all those interviewed indicates that 12,000,000 lb. a month is a reasonable figure to expect for the postwar adjustment period. (*Please turn to next page*)

[2] After these figures were compiled by the MODERN PLASTICS staff, they were given to members of the Plastics Branch of WPB for their suggestions and counsel. Although not permitted to divulge the actual figures, WPB officials gave their assurance that there was little difference between figures in the tables and actual allocation figures as shown by their records.






Urea and melamine, together with acetate and butyrate, are running comparatively close to capacity in their present production of molding powder.

The combined monthly total of ethyl cellulose, polystyrene and acrylics in the "current capacity" column is derived by adding 700,000 lb. of ethyl cellulose, 1,000,000 lb. of polystyrene and 400,000 lb. of acrylics. The acrylic figure is arrived at arbitrarily because it is the maximum of acrylic molding powder available, and it is not known how much of the present total production of 3,000,000 lb. of acrylic resin may be converted quickly to molding powder in the immediate postwar period. The ethyl cellulose figure of 700,000 is today's total monthly production of all types of ethyl cellulose. Even though a good portion of it is now used for other purposes than molding or extrusion, it is by no means certain that all those "other purposes" can be converted to peacetime uses. In addition, the producers expect an anticipated 50 percent increase which they hope to have by the end of the year. Thus the figures are arbitrarily weighted as between the acrylics and ethyl cellulose because the former's preponderant use is for sheeting and fabricating while the latter's preponderant use may well be that of molding or extrusion powder despite its proved value as flexible sheeting, film and strip-coatings.

There are so many imponderables involved that it seems unwise to make a positive statement on the future production of either acrylic or ethyl cellulose molding or extrusion powder. The current polystyrene situation is more definite. It is no secret that there is capacity to make 1,000,000 lb. a month, but styrene for plastics is not available due to benzol limitations. Even after styrene becomes available it will probably take from six months to a year to build facilities for the manufacture of additional polystyrene.

This increase in molding and extrusion powder *production* from approximately 10,000,000 lb. a month or 120,000,000 lb. (60,000 tons) a year in 1940 to a *capacity* of approximately 23,000,000 lb. a month or 276,000,000 lb. (138,000 tons) a year (exclusive of vinyls) immediately available if the war were to end soon in both hemispheres and restrictions were promptly lifted is a far cry from fantastic dreams of an industry that will provide employment for millions of persons and make millions of dollars for Johnny-come-latelies who imagine that the plastics molding industry will be the Klondike of the next decade. True enough, plastics will grow and those 276,000,000 lb., when added to figures for laminates, look well as compared to business totals a few years ago; but the industry is obviously not going to upset other American industries nor is it going to be a panacea for reconversion problems immediately upon cessation of the war.

The figures as shown in Table I are not news to most materials manufacturers. They were available to them, in partial form at least, long before they became public property. They have been the subject of much tongue-wagging as well as careful analysis in making plans for the postwar. Molding powder producers have been somewhat worried by the possibilities of over-expansion and the competition within the industry between various types of plastics material. The molder, too, is interested. He might lick his chops over the possibility of price wars if molding powder became overabundant, but there has seldom been a case in economic history where a price war between suppliers didn't reach down to the customer and affect his profits. Furthermore, the molder and the materials supplier must work hand in hand in the future, as they have in the past, to create new markets for plastic products. The increased production of molding powder has been largely used in war materials—the current estimate is 80 percent of thermosetting and around 50 percent of thermoplastic—and it is going to take considerable engineering and

selling to get this material back into its peacetime channels.

Vinyls are listed separately (Fig. 1) because there are so many varieties and a comparatively small amount goes into molding powder, although a large portion of the total output is used in extrusion. This study combines molding and extrusion powders. Production of vinyl resins was just getting under way in 1940 and accurate figures are not obtainable, but it is estimated that the amount used for molding powder alone was between 60,000 and 70,000 lb. monthly.

Present monthly production of all vinyl compounds is in the neighborhood of 15,400,000 lb. and well over half is presumed to be of the vinyl chloride type. Vinyl chloride resin with less than 92 percent vinyl chloride content is the type generally used for rigid molding while the more than 92 percent type is generally used for elastomeric applications. The amount at present used for molding and plastics extrusion (exclusive of wire insulation), plus the comparatively small amount of other vinyls that might be used for molding and extrusion, is conservatively estimated at about 1,500,000 lb. monthly.

It is foolish to foretell production of vinyl molding powder, because producers themselves will not even guess. Vinyls unquestionably have a future in the molding field, but at present their other applications are so many and varied that the business of educating molders to use them may be considerably delayed. Various vinyl types are already well established as extrusion material for tubing, screening and similar applications, but the total poundage figure is small in comparison with the vinyl used for other purposes. Consequently it seems best, for the purpose of this survey, to give total production figures for vinyls and let the reader use his own arithmetic, always remembering that they are certain to play a most important part in the extrusion industry. Perhaps their most important field will always remain in wire coating and fabric, but it is never wise to sell the vinyls short in the molding field. Potentially they are low cost, facilities are not unreasonably expensive and raw materials unlimited.

Nylon, polyethylene, silicones and other newer plastics are left out of consideration both because production figures are not available and because present use in either molding or extrusion is limited although all have postwar possibilities.

### The raw materials outlook

Here are some of the problems confronting the industry as a result of the expanded molding powder production.

Take the thermosetting branch first. New facilities have been constructed for the manufacture or stepping-up of such chemicals as benzol, formaldehyde, ammonia, phenol and other raw materials used in the manufacture of phenolic and melamine resins. A great portion of this material has gone into war goods.

Phenol is an example. These figures are not official, but they go something like this, according to reliable informants. Present production is around 17,000,000 lb. monthly. Around 9,000,000 lb. goes into phenolic resins for use in molding powder, coatings, varnishes, adhesives and specialties. Another 3,000,000 or 4,000,000 lb. of phenol is used for strictly war products such as ammunition. The balance is used for such things as drugs, intermediates, dyes, etc., that can ordinarily be used in civilian trade. But several phenol plants are not even in operation because of the benzol situation. It is believed that if every facility were used at full production, somewhere near 21,000,000 lb. of phenol could be produced each month. Immediately after the war ends, producers of phenolic resins will thus have at least 3,000,000 lb. of phenol now used strictly for war materials, plus present unused capacity, on their hands. It is likely that they will try to squeeze some into phenolic resins and then molding compounds.

The thermoplastic situation is even more uncertain and to a large degree hinges upon the availability of styrene monomer. At present something like an average of 33,000,000 lb. of styrene monomer are produced in this country each month. But capacity, according to a Government spokesman, is in the neighborhood of 40,000,000 pounds. A chemical company news story recently gave potential capacity as between 41 and 50 million pounds a month. According to Government officials, over 90 percent of that potential capacity is Government owned and thus could be theoretically turned off or on at Government command. It all depends upon how much styrene is used for synthetic rubber.

There is no crystal ball in which one can find an answer to the future of synthetic rubber production. The amount of styrene which may become available for polystyrene and potentially valuable styrene polyesters which have sprung up during the war is tied up in that riddle. But no realist believes that the total 40,000,000 lb. styrene monthly capacity is going to be left untouched under any circumstances. Today it would be possible to produce 1,000,000 lb. of polystyrene monthly if all capacity were used to the utmost. As mentioned previously, it would take perhaps a year to provide additional facilities. It is also unlikely that synthetic rubber production will be substantially cut for at least a year after war with Japan is finished. Thus there will be little more styrene available for plastics during that period.

If the reader could look into the situation several years after the war instead of anticipating the immediate future, it is possible that he might see something like this: polystyrene production alone exceeding that of all other molding powders put together if capacity and availability of raw material should remain the sole criteria; additional capacity built for acetate, butyrate and ethyl cellulose, with perhaps one-third of the present acrylic production or 1,000,000 lb. monthly devoted to molding powder; new plastic formulations plus unknown quantities of vinyl and nylon molding powders added to this total. It is not unreasonable to believe that 25,000,000 lb. of thermoplastic molding and extrusion powder may be available monthly a few years after the war is finished.

How about the capacity of processors to handle this potential increased production? First, it is pertinent to look at the current situation and its relation to the past as shown in Figs. 2 and 3. (*Please turn to next page*)

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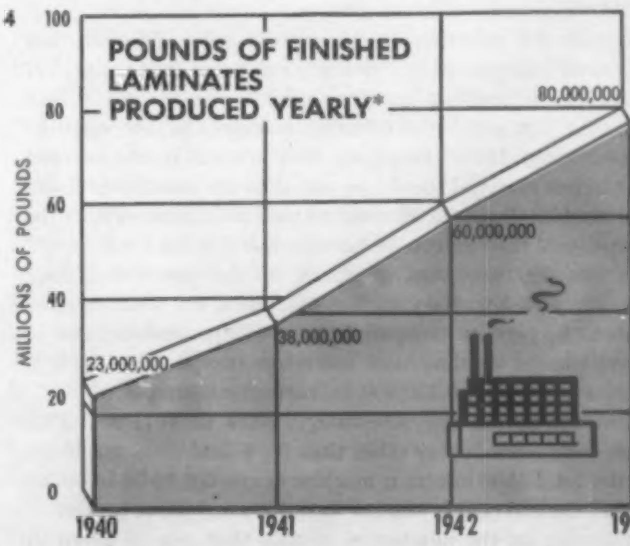



*These figures include company-consumed production

The number of firms to whom thermosetting molding powder is allocated today is slightly over 800, but less than 400 of them receive as much as 10,000 lb. a month. These 400 are the backbone of the compression molding industry. No one is counted in any of these figures who uses less than 1000 lb. a month. The 400 who use between 1000 and 10,000 lb. are largely companies who do their own molding of parts for some finished product manufactured in their own plants. A limited number are small molders who may become larger in the future.

The number of injection molders has increased from about 200 in 1941 to more than 320 today. About 160 companies are listed as doing both injection and compression molding.

No exact figures were obtainable on the number of extrusion operators in 1941. Today approximately 112 firms are doing all types of extrusion, including wire coating, casein and nitrate.

### Wartime increase of molding machines

The number of machines listed in Fig. 2 was compiled from figures given by individual operators, molding compound suppliers and machinery manufacturers, after consultation with WPB officials. At least 400 of the injection machines are 8-oz. or more.

The extrusion machines listed here are for plastics extrusion only separated into those used for coating wire alone and those doing other types of plastics extrusion. No rubber machines are listed. About 100 machines are working on acetate, the balance on nitrate, ethyl cellulose or vinyls. Note that 330 more are working exclusively on wire insulation and that the time may come when part of these machines will be diverted to other types of plastics extrusion.

From these statistics it can be ascertained that the 44 percent increase in the number of compression presses since 1941 has outstripped the 23 percent increase in thermosetting molding compound as indicated by the 12,500,000-lb. current production. This percentage of increase in facilities would be more impressive if it were weighted to allow for the larger presses and the automatic presses installed since 1941. It thus becomes obvious that facilities in the thermosetting branch of the industry are more than capable of handling the output of the raw material manufacturers even though a large number of the new machines may be used as replacements for older presses. And even if all the prospective phenol mentioned before were converted into molding powder, there would still remain sufficient press capacity to handle it.

Figures for injection machines look quite different, but they need interpretation. Statistics indicate that since 1941 thermoplastic molding powder production has increased 165 percent. The number of injection machines has increased 50 percent since 1941. Some of the extrusion machines used for plastics material should be added to the number of injection machines because compounds used for extrusion with the exception of the vinyls have been included in the total.

If the 350 extrusion machines of the non-wire-coating type are added to the injection machines, the total increase is about 85 percent, compared to the 165 percent increase in thermoplastic molding and extrusion compounds which is listed at a total of 6,350,000 lb. current consumption.

But the figures are misleading. Back in 1941 and 1942 there were scarcely any other than 2-, 4- and 6-oz. machines. Of the total 1500 injection machines expected to be in operation at the end of this year, at least 400 are 8-oz. or better.

Figuring on the number of pounds that can be eaten up per hour in normal operation, there seems no doubt that the 400 8-oz. machines or better can use as much or more molding material than the 1100 older and smaller machines. A materials supplier has estimated that all today's injection machines of 6-oz. or under could use 27,000 lb. an hour under normal operating conditions and without "forcing" larger amounts than the normal charge. Under similar circumstances, all machines of 8-oz. or over could use up approximately 20,000 lb. an hour. Consequently it is obvious that the capacity of processors to handle molding compounds has increased out of all proportion to the actual number of presses.

Attention should also be called to the 12-hr. average work day in 1941 compared to a 24-hr. day which is worked at the present time. If the industry could handle 2,400,000 lb. of thermoplastic compounds a month in 1941 in a 12-hr. day with 1000 smaller presses, they can handle at least 4,000,000 lb. a month today in a 24-hr. day, and the new and often larger machines plus 100 or more extrusion machines will take care of the remaining 2,350,000 pounds.

It is conceivable that thermoplastics processors can also handle the "current capacity" of 7,500,000 lb. a month especially when machinery manufacturers get into full-scale production of new machines. Obsolescence of facilities is, of course, a factor after the last four years of hustle and bustle. There have been very few replacements during this period and operators are eagerly awaiting the day when obsolete or worn-out machines can be melted down for scrap. If the emergency should last over an extensive period, this situation would seriously interfere with production, but fortunately most of the obsolescent equipment ranges in the small sizes.

### Postwar plant expansion

From this over-all increase of 44 percent in compression and 50 percent in injection presses in approximately three years, one could infer that the industry might very well be satisfied with its physical proportions. Such is not the case, however, if face value is placed on the analysis of replies to the specific question asked both molders and laminators which reads: "*Have you definite plans for additions to your plant and if so, by what percentage will the additions increase your plant size?*"

Fifty-seven percent of the molders who returned questionnaires answered "Yes"—and this percentage was roughly duplicated in personal interviews which, of course, gave voice and color to detailed description and discussion of expansion plans not possible in the cold light of questionnaire analysis. The most conservative methods possible were employed in ascertaining the composite percentage of planned expansion. Questionnaires which stated "Yes" but indicated no definite percentage of increase could not be included.

The final tally showed that the molding industry is planning a 21 percent postwar expansion.

The machinery trend is toward larger and larger capacity, hence faster production and lowered cost to the consumer. One of the leading press manufacturers plans to produce only 10 4-oz. injection presses this year, while his 6- and 8-oz. schedule is for 60, and 3 each of 16- and 22-oz. machines are on the agenda. Even 36-oz. and upward presses are in the talk and blueprint stage.

The survey reveals that a majority of the compression molders are either using or plan to use high-frequency units as soon as possible. The returns indicate that 62 percent of the industry's compression molding may be "high-frequency" heated when equipment is available and it can be used for heavy sections or parts.

Molders' answers to the question, "Has high frequency increased production?" were a (*Please turn to page 202*)

*1—So closely are the materials of sculpture related to the character of the finished art that plastics with their almost limitless variety of colors and textures have opened new fields of expression to the artist and given him a freedom unobtainable when natural media were his sole materials*

# A medium for sculpture

by JAN and URSULA de SWART

BECAUSE the materials of sculpture intimately determine the character of the finished art, the contemporary artist finds plastics an ideal medium of expression. Plastics liberate him from the traditions and limitations of natural media. They combine the colorful clarity of glass, the massiveness of stone, the permanence of marble, the mobility of clay, the warm surface of wood, the yielding rigidity of ivory. Yet they are not prone to shatter or crumble, split or break. It is no longer necessary to restrain a design to the compactness demanded of stone or wood-carving, for plastics will allow themselves to be shaped to almost any desired form—from a solid mass to the most fragile contour—without danger of breakage. If it is true that the resistance of the material affects the formal and emotional quality of an artist's ideas, then the facileness of plastics must give the carver a freedom and fluidity of expression that will be a revelation.

The essential modernism of plastics lies in their affinity for light. It is for this reason that translucent and transparent blocks of plastic most deeply fascinate the sculptor. The sensation created in the artistic mind by looking at a block of this material is so stimulating that it surpasses any comparable experience with other media. One can look at it, into it, through it and beyond it—into the undreamed of realms of color and form that grow out of the contours, planes and reflections of the clear block.

The semi-transparent plastics are variously translucent—shading, for instance, from deep rich amber in a solid block to palest honey-gold where the carving thins to a delicate detail. The reflections and iridescences of the material can be used to heighten the tri-dimensional effect of the carving. By an ingenious elision of planes and a simplification of modeling, the tactile impulse of the beholder, which is so intimately a part of sculpture, can be aroused to a higher degree through translucent plastics than by almost any other medium that is available to the artist.

The non-transparent plastics form another group embracing thousands of varieties: the pure, solid colors, alabaster and marble effects, tortoise shell (which is made by mixing

different colors so that they form a natural flow in pattern); the plastics impregnated with silver, aluminum, bronze and other metals. There is no limit to the diversity of effects that can be created by mixing different plastics or mixing different materials with the plastics. We are only now awakening to the possibilities of enriched expression it will offer to the creative artist.

## Problems of a new medium

The sculptor desiring to work in plastics must be fully aware that he faces an entirely new medium, and that he must find a new idiom to reveal it as well as new tools to manipulate it. Different plastics demand different tools. Some of them can be carved, others must be chipped. Most of the existing plastics are best manipulated by a tool that can be pulled instead of pushed. They can be handled successfully with a very coarse saw and roughly cut to shape. Power tools of various kinds are excellent if the right knives and drills are designed for this purpose. Sanded or chipped effects can be contrasted with polished surfaces, and many interesting textures may be achieved by the imaginative use of the tools. Different grades of sandpaper, steel wool and buffing rouge, used in this sequence, will give the carving a high optical finish.

Since there is no grain or visible structure in this material, a variety of surface treatments which would not be commensurate with natural media is entirely congruous in the sculpture of plastics. With tools designed by an artist to suit his own particular style, he can create unusual techniques. If

***2—The reflections and iridescences of semi-transparent plastics which shade, as in these models, from a rich soft amber to palest honey-gold, heighten the tri-dimensional effect of the carvings and give them added beauty***

he wishes to reproduce the originals, however, he must evaluate his technique in relation to the method which he chooses for the reproduction.

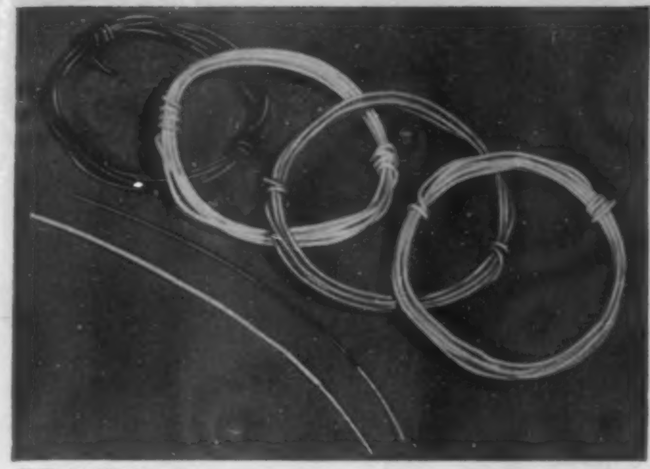
The process of casting reproductions from an original carving begins with the designing of the sculpture. The design should be adaptable to a two-piece mold and planned so that the cavities of the casting can be reached with the buffing wheel. Where this is not possible or desirable, the deeper cavities may be sand-blasted to contrast with the higher planes of the carving which can be buffed to a polished finish. If the piece is to be cast in clear material, it is important to make the original carving in transparent plastic also, for the character of the entire design is modified by the imposition of the lines of the back upon those of the front of the sculpture, as well as by the foreshortenings, reversals and veilings peculiar to decorations on a rounded, transparent form.

The choice of a mold depends on the character of the piece to be reproduced. There are certain types of rubber which will take care of an undercut in carving. There is a wax that will stand the curing temperature of the plastic cast. Plaster of Paris may be used when it is given a finish with a special lacquer. Lead molds are suitable for certain resins. Finally there is the plastic mold.

A distinct advantage is gained by using very hard wax, in that after the mold is made, a glassy finish which gives the reproduction an unusual luster can be created by quickly brushing over the surface with the flame from a blow-torch. A similar technique is employed in the dental laboratory. An excellent permanent mold can be made by using the same resin from which the reproductions are to be cast. This material can be beautifully polished; and the mold, when well designed and treated with the proper lubricant, can be made to stand considerable use. Since these are comparatively slow processes and since they demand the skill and patience of an expert, the cost of reproductions will always be relatively high and tend to prohibit the use of this technique for mass production. Most of the techniques are far from perfected. There is a great opportunity in this field for experimentation and individual exploration.

More far-reaching than its application in purely expressive art wil' be the use of plastic sculptural design in its decorative and functional aspects. No other material is so representative of the spirit and form of modern architecture, or so compliant with the trend toward simplicity and beauty in the American interior. According to its use, plastic will absorb the color and contour of its surroundings or accent and dramatize other materials and forms. Light may be guided through plastics with striking effects: a door carved in translucent plastic and so illuminated would be a thing of beauty as well as a source of inviting light; a carved mural of leaves cut from plastic sheets might be lighted by a plastic rod winding through the design as an integral part of the sculpture. There is a need for lamp-bases, book-ends, flower containers, of high artistic caliber, expressive of the contemporary spirit and suited to modern conditions of use. For these and innumerable items of interior decoration, plastics are an ideal material. Their effectiveness in color photography and television is also worthy of note, for by these means the beauty and value of plastic products will, in the future, be conveyed to all the world. And it will be a world hungry for color after these years of war with its attendant drabness on both the battlefield and the home front.

*The material used by Jan de Swart for the sculpture which is shown in the 4-color illustrations appearing on these two pages is Tenite.*



PHOTO, COURTESY OKONITE CO.

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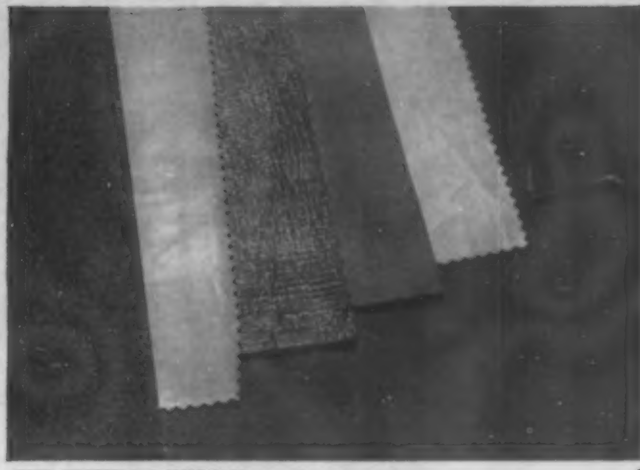


PHOTO, COURTESY B. F. GOODRICH CO.

2

*1—Exceptionally thin-walled insulation can be made from this vinyl latex. 2—The finish on these vinyl latex coated fabrics ranges from dull to mirror. Most standard solution coating equipment can be converted to the use of this latex*

# Water-dispersed vinyl resin

by GEORGE W. FLANAGAN*

VERSATILITY is the fortunate attribute of vinyl resins which made possible the rapid exploitation of the good processing properties of these materials in the fabrication of peace and wartime products. Consequently, a further extension of the utility of vinyls is a subject of interest to those who have already become familiar with their technology. Added usefulness has been achieved in the development of a high solids water dispersion of a vinyl chloride type resin known as Geon latex. The new latex is the result of a long search for such a material and its introduction is in a large measure based on the researches of Dr. G. W. Smith of the B. F. Goodrich Research Laboratories. Currently, the vinyl latex is made in full-size production equipment and used in several applications of a military nature—chiefly as protective coatings. Studies are being continued to produce a raw material of even greater adaptability. When allocations are no longer needed to obtain it, the new latex will find a variety of uses in a number of industries.

The new dispersion of vinyl resin is accurately described as a latex since it is a milky-white liquid containing particles spherical in shape and uniform in size—less than one-tenth micron in diameter—suspended in water. It is formed as such in a carefully controlled polymerization process. The latex is a stable colloidal system able to withstand the mechanical stresses inherent in many processing operations as well as temperatures up to the boiling point of water. Stability has been obtained by reason of the small particle size and by the presence of small amounts of materials that tend to form protective envelopes about the particles. Examination of a sample on a dark field microscope will reveal that the disperse phase is in vigorous Brownian movement.

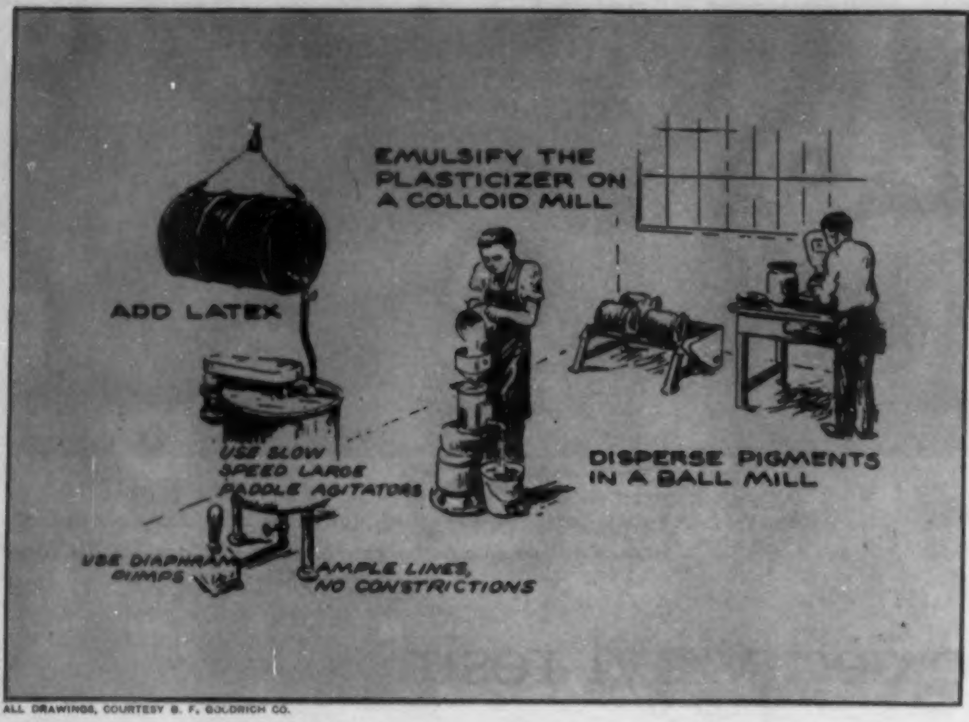
A property which has great influence on stability relates to the nature of the electrical charge on the suspended particles. Since this charge is negative, the vinyl latex exhibits some of the behavior common to natural rubber latices. Coagulation can be brought about by the addition of electrolytes—especially those with polyvalent cations—or by the action of certain organic solvents such as alcohol. The latex is most stable in an alkaline medium, preferably at a pH of about 8.5. On prolonged storage, this value will fall off somewhat but may be restored by making up the alkali deficiency with ammonia. Latex handled in this way will remain stable indefinitely.

While there are similarities in form and, to some degree, in properties between vinyl and rubber latices, there are certain characteristics which are peculiar to the new material. These distinctive differences must be recognized and understood in order to work out methods of formulation or processing useful in practical applications. For example, the vinyl latex, because of its chemical nature, cannot be vulcanized without resorting to special techniques. Perhaps the most contrasting property so far as processing is concerned, is that of plasticity. Where rubber latex particles are pliable and tacky at ordinary temperatures, the vinyl resin particles are, on the contrary, hard and almost completely lacking in cohesion. A comparison of latex deposits dried at room temperature demonstrates these facts quite adequately; the rubber will be in the form of a fairly strong film whereas the unplasticized vinyl resin will be a dry, loose powder.

Under proper conditions, however, vinyl latex is a film-forming material. There are two requirements that have to be met to obtain good coalescence of the dispersed resin: first, incorporation of a plasticizer and second, correct heat treatment of the applied latex formulation. Plasticizers perform the same function they accomplish in conventional vinyl resin processes, the only difference in latex technology being the manner in which they are used. This will be discussed under a subsequent heading.

Heat treatment is a necessary adjunct to almost any procedure that involves processing vinyl resins. When dealing with vinyl latex, the application of heat serves a twofold purpose. It is a means of removing the water from a latex compound and, once this is completed, is the agency that

* Development engineer, Chemical Div., B. F. Goodrich Co.




ALL DRAWINGS, COURTESY B. F. GOODRICH CO.

*3—At the end of this formulation process, the compounded vinyl latex is ready for spreading, dipping, spraying, roller application, air knife coating, etc., without the use of organic solvents*

softens the resin, thereby allowing the surface tension of the resin itself to cause complete fluxing into a continuous, homogeneous deposit. By virtue of these conditions, it follows that vinyl latex lends itself to continuous processing methods.

## Modification by formulation

Generally speaking, the practical utilization of any latex system involves two classes of operations. These include formulation procedures and, secondly, application methods. Formulation covers all the techniques by which materials, usually in disperse form, are blended with the base substance in order that the finished article made with the latex compound will have certain desirable properties. Vinyl latex is like other latices in this respect. Most of the variations that do occur are differences in degree of behavior rather than evidences of unique phenomena.

One modifying agent common to nearly all vinyl formulations, whether in latex or dry resin form, and which may or may not be present in rubber latex mixtures, is some type of plasticizer. The same types used in handling vinyl resins by conventional hot mill or Banbury technique can be used in compounding latex. Plasticizers are readily emulsified and are, therefore, added to latex in the form of concentrated emulsions of the oil-in-water type. In certain kinds of work, such as processes that require mixtures of very high solids content or high viscosity, it has been found feasible to disperse plasticizers directly in the latex itself. In cases where subsequent processing conditions, service conditions peculiar to the finished article or economic reasons are of importance, the possibility of blending several plasticizers in one recipe is worthy of consideration.

Table I.—Properties of Geon Latex

| | |
|---|---|
| Solids content, percent | 50 |
| Viscosity, centipoises | 10–15 |
| Surface tension, dynes/cm. | 55–60 |
| Specific gravity of latex | 1.16 |
| Specific gravity of resin | 1.35 |
| Charge on particle | Negative |
| Particle size | < .1 Micron |

It has been found that colors, extending pigments, resin stabilizers and other solid materials should be dispersed carefully when they are to be used in vinyl latex compounds. This is necessary because concentrated latices of small particle size possess appreciable surface activity and are consequently more sensitive to the influences of any dispersions which may be introduced. Thus, a compound designed for a particular purpose may be quite complicated in colloidal aspect due to the number of substances that contribute to its heterogeneity.

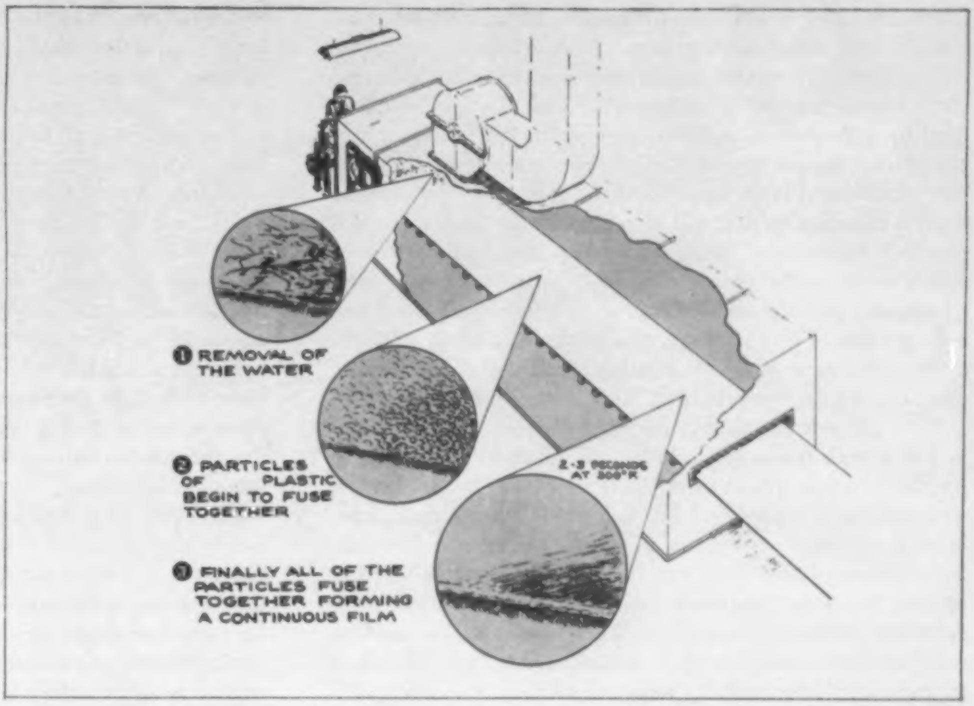
## Preparation of latex compounds

The equipment used for preparing dispersions and blending them with latex is standard. Colloid mills present the best means of making good emulsions and are also useful in deflocculating those materials that have fine particle size but which normally yield slurries with coarse aggregates after simple stirring. Ball mills, especially the larger types, produce excellent dispersions where grinding action is necessary. Although blending operations can be carried out manually, the most effective method is to combine ingredients in a tank fitted with some form of mild agitation, such as a paddle stirrer driven at low speed. Uniform batches of good stability are obtained by this arrangement.

The water-soluble materials that are useful in vinyl latex compounds may be added at any point during the blending operation where they are likely to be most effective. Agents of this sort generally include colloid stabilizers (not to be confused with vinyl resin stabilizers), such as casein and auxiliary wetting agents. The former are incorporated with the latex prior to blending with other dispersions, and the latter at the time the compound is used.

## Processing

Successful adaptation of a new form of a material with well-known inherent properties is never a simple matter. A number of new conditions have to be studied and new limitations must be considered before complete processes can be set up. All latices have limitations and the vinyl variety is no exception. However, there are many situations in which an




*4—In film formation, the vinyl resin passes through 3 distinct stages. The changes in the composition of the material are clearly evident in the three circles which represent magnified sections*

analysis of comparative methods will demonstrate that the advantages of a latex system outweigh the limitations. As an example, there are several factors subject to scrutiny when the relative merits of a water-dispersed system are compared to those of a solvent system when applied to, let us say, a fabric-proofing job. Latex methods do away with solvents and solvent recovery systems. In the case of vinyl latex, it is possible to obtain better adhesion to fibrous or cellular-base materials than can be achieved with solvent solutions of the same resin. High solids with high fluidity also favor the choice of latex when operation time and cost are important. The argument for solvents is more favorable when one considers that the shrinkage of base materials is negligible when using solvent solutions and that very little heat is necessary to secure continuity of deposited resin. For new installations, the opportunities for design are such that latex technique is well worth consideration. On the other hand, the economy and simplicity of latex methods are often factors of enough importance to warrant modification of existing equipment to handle either latex or solvent systems.

In spite of the heterogeneous nature of vinyl latex, it can be used with many types of equipment developed for the processing of resin solutions. There are a number of coating machines in the paper and fabric conversion fields that have been used successfully with latex compounds. Knife coaters, air knife machines, roller applicators and continuous dip tanks may be mentioned as examples. Compounds of proper consistency can be established to fit the requirements of different methods. High-viscosity formulations are desirable for most spread-coating work whereas dilute, highly fluid compounds usually perform best in dipping processes.

No matter what type of applicator is used, it ordinarily must function with storage and transport facilities. It is here that adjustments or modifications are usually necessary. Tanks, pipe lines and fittings should contain no copper or zinc if discoloration or possible resin decomposition is to be avoided. Iron vessels have no bad effect on the resin but cause some discoloration on long storage. Stainless steel, wood and ceramic ware are quite satisfactory. Almost any surface coated with a phenol-formaldehyde varnish can be used in contact with latex compounds. Transport of colloidally dispersed systems is not as simple as in the case of homogeneous solutions because the former are apt to coagulate and plug up pipe lines if forced through restricted channels. The use of lines with adequate capacity and a diaphragm pump will minimize these difficulties. Straining or filtration after formulation is advisable to remove the small amount of lumpy material or coagulum that may be present. The compounds should be agitated to keep them uniform in composition, and they should be kept covered to keep out dirt as well as to prevent skin formation.

There are a few important principles that should be kept in mind in connection with the heat treatment of vinyl latex compounds. Although high solids content permits laying down substantial deposits during a single application, it is well not to go too far because heavy films may result in surface hardening and cause blisters due to the entrapment of some of the water. After elimination of the water the resin should attain a temperature in the neighborhood of 300° F. to obtain the best physical properties. A few seconds at this temperature will usually suffice; longer heat treatment at a lower temperature will not develop as good properties. Complete heat treatment after each application of latex, begun while the deposit is still wet, is the most satisfactory procedure. In those cases where subsequent applications are made it is usually necessary to modify the compound with an auxiliary wetting agent since fused latex resin is quite resistant to wetting in subsequent operations.

Despite high resin content, the vinyl latex is quite fluid. Consequently, it is often desirable to thicken a latex compound in such a way that its performance will conform to some accepted procedure. This can be done by using hydrophylic materials that have a marked effect on viscosity even when added in small concentrations. Among these agents can be listed casein, alginates and some of the water soluble acrylic resins.

### Process control

Measurement of the physical and chemical properties of vinyl latex compounds is a useful method of obtaining in-

formation to serve as a basis for making adjustments in compounds or in designing new ones. Such properties as viscosity, stability and surface tension may undergo change during storage or actual use of compounds. Viscosity can be measured by a number of methods, both in the laboratory and in the plant. Estimation of stability is not always easy. The user of the vinyl latex should design the stability test so that it gives information that will be related to the kind of stresses to which a particular formulation is subjected. Surface tension is a very useful property to study because it can be used to evaluate the surface activity of emulsions, dispersions or latex. Data of this kind are invaluable in studying the efficacy of different soaps or wetting agents, and their effect upon the wetting properties of latex compounds.

Tests suitable for plasticized vinyl resins or for the articles in which such resins are included are naturally applicable to finished products made from plasticized vinyl latex. Once a composition is completed the fact that it was made from latex is no longer obvious or in some cases even discernible. Standard tests, therefore, can be used to determine whether or not the heat treatment has been adequate to develop optimum physical properties. They can also be used to compare the relative merits of products made by the different procedures of latex and dry resin processes.

## Applications

A number of interesting developments have demonstrated that the useful properties of polyvinyl chloride resins can be achieved by the new technique of using these materials in disperse form. Paper coatings with excellent grease resistance have been made which have been used to package ordnance equipment. Fabric proofed with vinyl latex has met the requirements for abrasion resistance and flameproofness in certain materials used by the Navy. Hospital sheeting and foul weather clothing have also been produced. Experiments have shown that there is a good possibility of developing coatings for lightweight fabrics so as to render them resistant to water but still permeable to air.

The properties of flameproofness, good dielectric strength, toughness and abrasion resistance have been taken advantage of in the development of thin-walled insulation for wire. Tests have shown that insulation obtained by latex technique has good electrical properties for many postwar uses. Work at the present time is being directed toward the objective of easing the critical shortage of dielectric materials caused by unprecedented military demands.

Impregnation is a field where vinyl latex can be used much more effectively than solutions of the same or similar resins. Penetration of fibrous materials can be controlled by adjusting the solids content, viscosity and surface tension. The same circumstances, chiefly small particle size and mobility, which cause good adhesion of latex films to fibrous materials can be used to realize excellent impregnation of textiles, compacted fiber and similar materials. Resin in latex form introduced to fibrous materials can be utilized as a bonding agent to secure products of good water resistance, high impact strength, mildew-proofness, flame resistance and other varied properties by resorting to hot press methods.

## Summary

This discussion has been presented to describe the nature and properties of a unique material known as Geon latex, now available to industry, subject to the limitations imposed by the War Production Board. On the basis of its behavior under various conditions, processes have been worked out which have been applied to the manufacture of a number of useful products. Vinyl resin technology has thus become broadened in scope.

DRAWING AND PHOTO, COURTESY B. F. GOODRICH CO.

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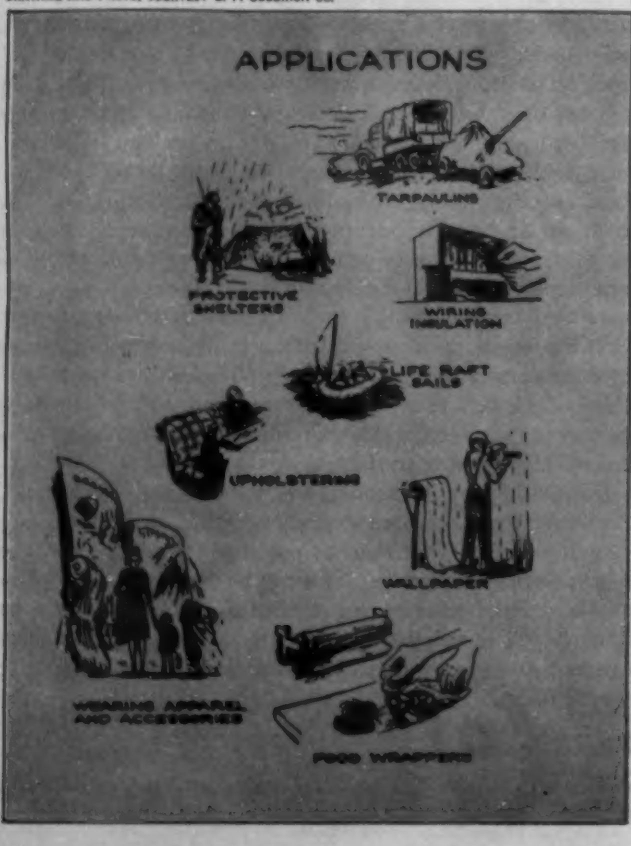
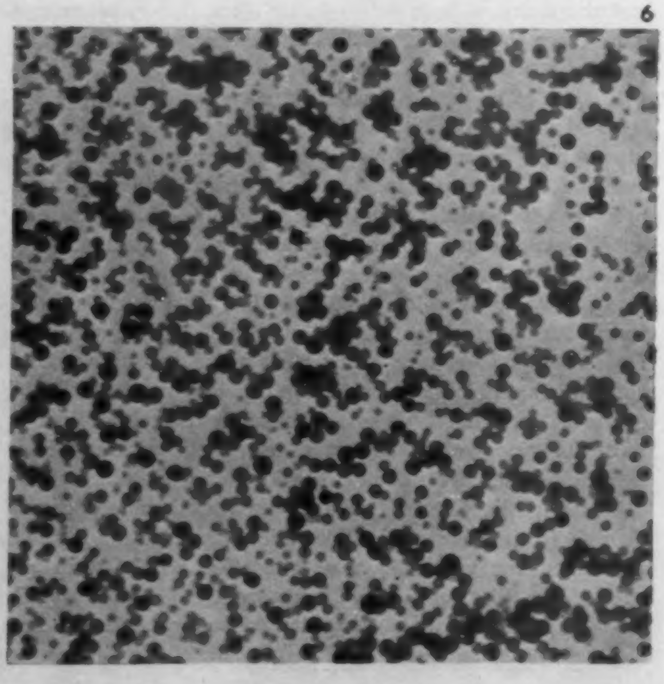
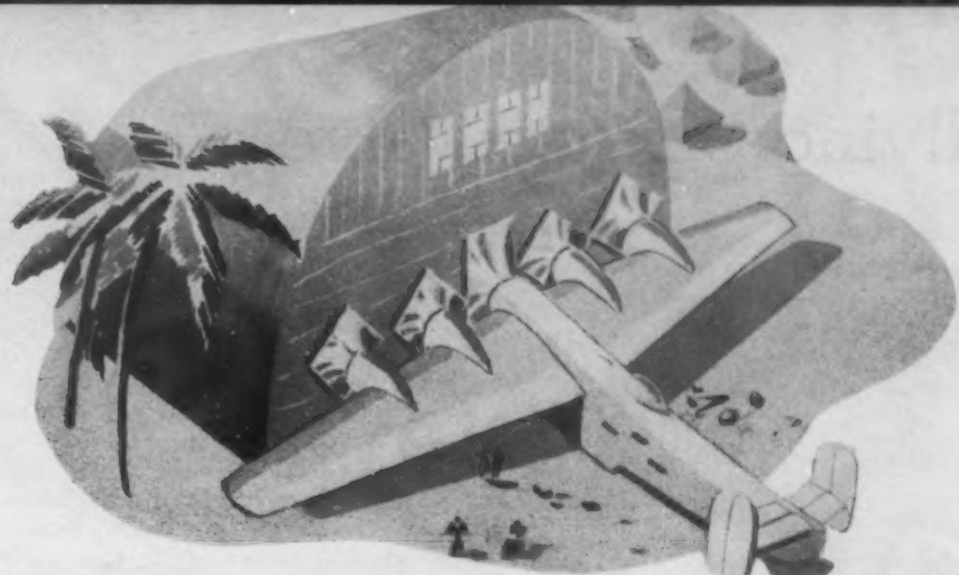



*5—Typical applications include protective shelters, wiring insulation, upholstering, wall-paper, wearing apparel and food wrappings. 6—This electron photomicrograph of 32,400 diameters shows the extremely fine and uniform particle size of the resin (about 0.1 micron)*

6





# Portable hangars for Navy aircraft

WORK on an airplane is never done. Before and after every mission, planes must be checked for damage or points of weakness so that they will be in perfect condition when they leave the ground—or in as good condition as the facilities of the ground crew can make them. To insure that this necessary maintenance work will go on despite the vagaries of the weather, the U. S. Navy supplies portable vinyl-chloride acetate impregnated canvas covered hangars to its many outposts. Whether the field is in the Far North or close to the Equator, the canvas covering offers full protection, for the material is not only processed against the ravages of fire, mildew and rotting but given an arcticizing treatment which keeps it flexible at 40° below zero. Furthermore, when work is finished at one field the canvas can be easily rolled up and moved forward to the next advance base.

Although the original hangars were constructed to service only one plane at a time, the units presently in use are large enough for a two-motored plane to be serviced at one end while a four-motored plane is being repaired at the other. The sketch at the top of the page illustrates the way in which planes are placed half in and half out of the hangar with special canvas socks—slipped over the motors and fuselages and laced to the canvas end pieces—to seal the openings.

Each hangar consists of a steel arch covered with vinyl-chloride acetate impregnated canvas. The Textileather Corp. calenders a 0.004-in. film on single texture duck and then laminates two sheets together with a wet solution. The laminating is not done when the canvas is calendered because inequalities in the cloth might cause a leak, whereas the laminating solution seals in the material to give high hydrostatic resistance when it is added in a second operation. In the next step the two sheets, which are now laminated together, are impregnated with a vinyl resin base fire-, water- and mildew-resistant solution and colored olive drab. After processing the completed fabric is dipped in a bath. Drying time is about two minutes in an oven that is maintained at a temperature of 275° F.

From start to finish the entire treatment and processing of a given batch of canvas requires little more than 8 hr.—a speed that makes it possible for (*Please turn to page 210*)

***1—Aircraft in distant outposts are protected from the elements, while being serviced, by these portable hangars. 2—The resin impregnated canvas hangar covering is divided into 21 sections for easy handling. 3—These canvas socks provide a tight seal around the plane's motor and fuselage as they project through the end curtains***

2 PHOTOS, COURTESY INTERNATIONAL DERRICK AND EQUIPMENT DIV., INTERNATIONAL-STACEY, CORP.

3

# High-flying oxygen valve

by IRVINE G. GODDARD* and I. GOLDBERG**

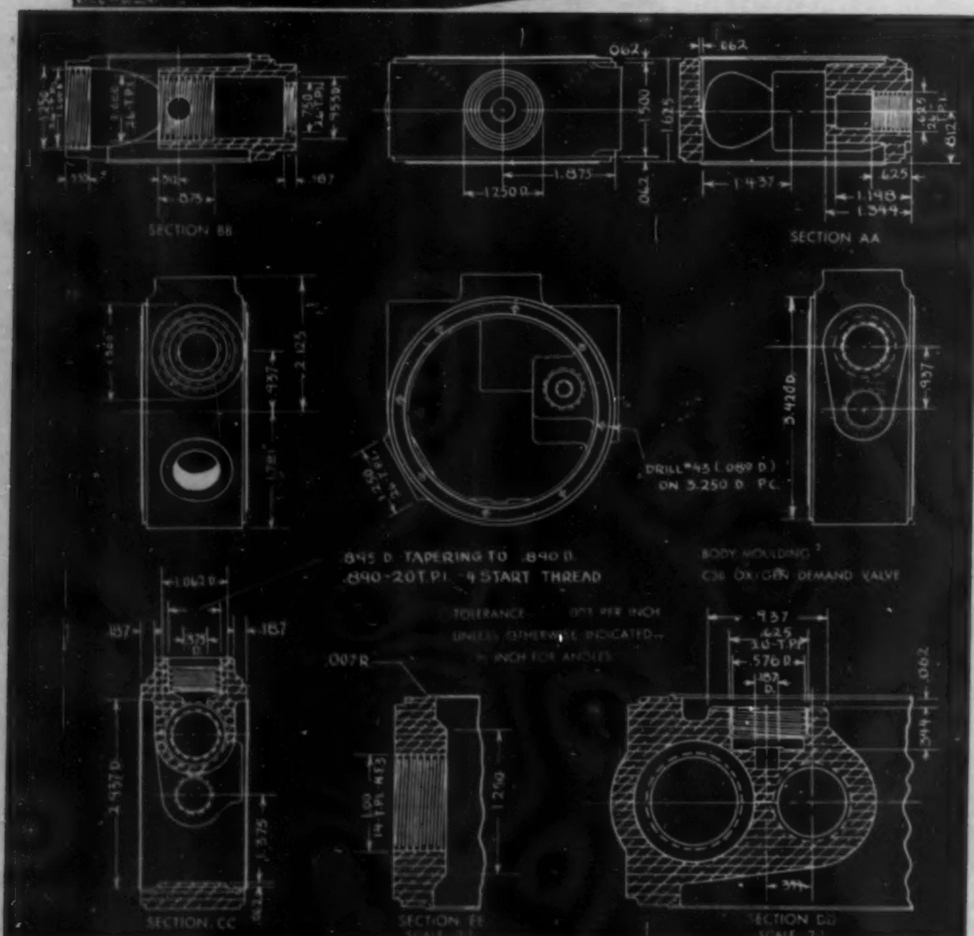
1

TO AIRMEN fighting in the thin upper air five or six miles above the earth, proper supply of oxygen means life or death. Diving and climbing at 400 mile an hour speeds, gaining or losing 10,000 feet in minutes, the oxygen supply must at all times be sufficient. The airman has no time to fiddle with controls but he must be sure that his oxygen equipment will function properly so that he can concentrate on the job he has been trained to do—shooting down enemy aircraft. The higher the altitude, the greater the quantity of oxygen that is required, since oxygen sufficient for an altitude of 15,000 feet will bring unconsciousness in a few seconds at 35,000 feet.

Previous methods of supplying oxygen were found to be insufficient, mainly because of: 1) the higher altitudes at which flying occurs today, and 2) the greatly increased length of time that airmen are required to stay at these altitudes.

In early developments, oxygen was supplied continuously at predetermined rates. This method required constant attention on the part of the airman and was found to be very costly for high altitude flying for long periods. The majority of present-day oxygen systems use what is known as a demand valve. This piece of equipment supplies oxygen only on demand of the inspiration or intake of breath of the airman; during expiration or expulsion of breath from the body no oxygen is used. Obviously, such a system makes possible a

* Engineer, Plastic Sales, Canadian General Electric Co., Ltd.
** Assistant technical director, Canadian Aircraft Instruments and Accessories, Ltd.

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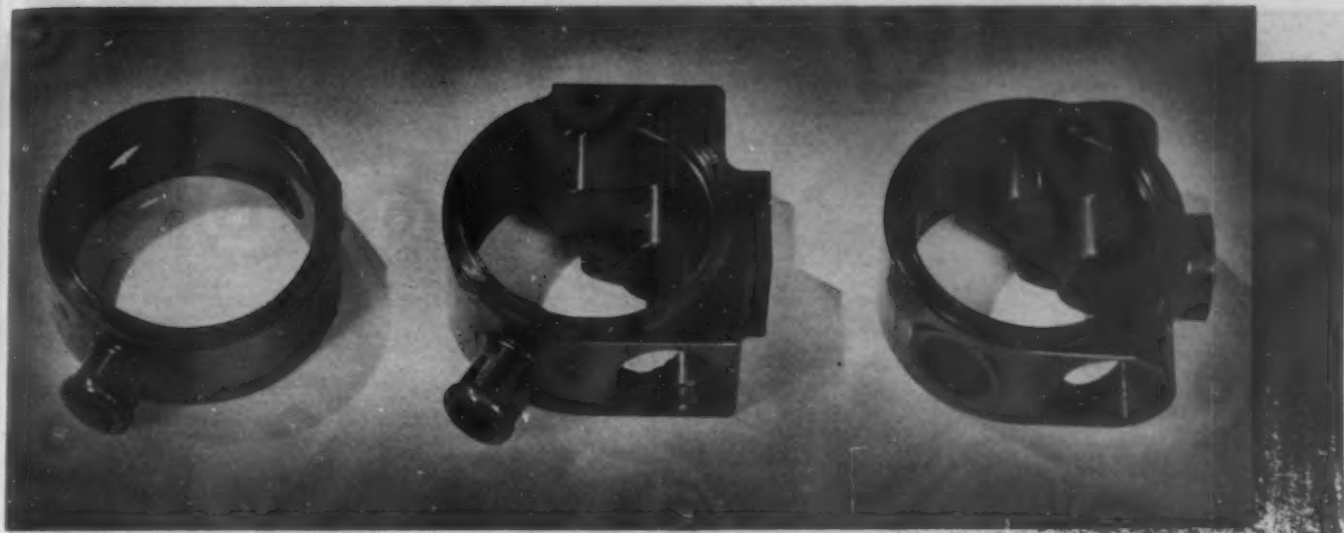
*1—Airmen are assured of a constant supply of oxygen at any altitude with this demand valve which requires no manual control. 2—This drawing of the valve in present use illustrates the difficult molding problem which was presented by the juxtaposition of thin and heavy sections in a single mold*



3

3—*Three stages in the development of the oxygen demand valve body. The present design (right) eliminates as many complementary parts as possible, simplifying assembly work*

tremendous saving in the total amount of oxygen to be carried for long flights.

The R.C.A.F. air oxygen demand valve which was first developed in 1941, not only operates on the demand principle but includes an automatic feature which guarantees that the correct amount of oxygen is supplied to an airman for any given altitude. At 14,000 feet, from 5 to 10 percent additional oxygen is more than sufficient for the requirements, whereas at 30,000 to 34,000 feet 100 percent oxygen must be used. Thus, besides providing for fully automatic action, this demand valve insures the saving of additional oxygen due to the fact that at low altitudes the consumption of oxygen is considerably less.

Development work of the R.C.A.F. air oxygen demand valve was undertaken as a joint co-operative effort by the Medical Section of the R.C.A.F. and the National Research Council of Ottawa, operating through its members at the University of Toronto. Major portion of the work was done by Flight Lieutenant F. E. J. Fry of the Clinical Investigation Unit, Medical Section, R.C.A.F., and Professor H. Grayson-Smith of the University of Toronto.

The principle of operation is relatively simple. During the intake breath a partial vacuum is created inside the demand valve body—allowing a diaphragm to move. This diaphragm, through a mechanical linkage, opens the valve to the oxygen supply. The oxygen is allowed to flow into the demand valve body through a chamber which operates an air valve. The mixture of air and oxygen passes into the mask and, from there, into the lungs. By this arrangement the flow of oxygen is assured before air is admitted, and the amount of oxygen that will flow depends on how deeply the person breathes.

The opening of the air valve is controlled by an opposing mechanism sensitive to altitude. Thus, at Sea Level full opening is allowed, but at approximately 30,000 feet the air valve is held tightly closed. In this way the mixture of air and oxygen is proportioned continuously from Sea Level to 30,000 feet. Above 30,000 feet only oxygen is allowed to flow. This whole mechanism is entirely automatic in its operation and does not require any attention on the part of the person using it.

Although the principle described above is simple, considerable development and modification were required before an acceptable production type air oxygen demand valve was made available. More than 150 modifications were made in the course of development in order to eliminate all the bugs that occurred and to produce a unit which could be depended upon and required little or no (*Please turn to page 210*)

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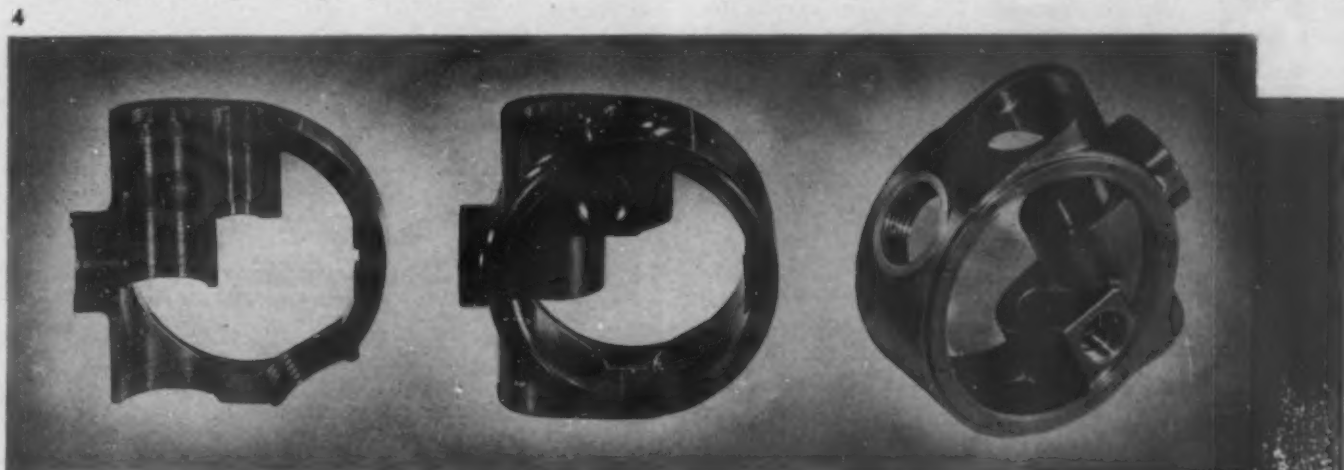

4—*A cut-away section and two complete valve bodies, showing the seven different sized threaded holes in three planes which must be molded in one operation to a Class 2 fit*


ALL DRAWINGS, COURTESY GEORGE G. SHARP

*River boats of the postwar era will rival luxury ocean liners in the perfection of their appointments. The* SS Chattanooga, *which is shown here, is typical of a projected series of these ships designed for inland waterways*

WHEN the new queen of the Tennessee River boats makes her maiden voyage after the war, 300 pleasure-loving passengers will have their first taste of accommodations rivaling those of prewar round-the-world ocean liners. More than that, they will find features, comforts and innovations never before incorporated in a ship plying inland waterways. And prominent among them will be new watercraft applications of plastics.

## Present developments

Already named the *SS Chattanooga*, this ship is no "dream boat." Designs have been completed by George G. Sharp, New York naval architect, and preliminary plans have been made for its construction in the Decatur, Ala., yards of the Ingalls Shipbuilding Corporation. This revolutionary craft will operate on a year-round basis for motorists, vacationists and conventioneers and will make 1300-mile weekly trips from Knoxville to Paducah and return. Top speed will be about 18 miles an hour.

One of the first things *SS Chattanooga* passengers will see when they board the craft will be a giant "blister" atop the pilot house. This will be formed of transparent plastic and is designed to give the pilot a 360° range of vision. Not only is this important from the standpoint of safety but it is a "must" if morale is to be maintained among river pilots accustomed to the full view provided by the old stern- and side-wheelers. The idea for this transparent pilot-house dome was borrowed from warplane design, and the blister will be similar to those installed in our Army bombers for the top turret gunners.

## Plastic decorations

Designers of the new ship state that plastics will also be applied in other features and appointments on the ship—including decorations and trim—all of which will represent radical departures from the usual design of river craft. For bedrooms such as that shown in Fig. 3, transparent plastic will be used for the dresser knobs and lamps, picture frames and chair arms. These clear plastic chair arms have also proved popular in the dining room and lounge. These are the rooms that are invariably air-conditioned on modern luxury cruisers with the result that the metal furniture frequently used in these sections is cold to the touch. Men, well insulated by an outer jacket, may never be conscious of the icy touch of such metal chairs. But the same cannot be said of women dressed for dinner in low-cut, sleeveless gowns. Plastic chair arms overcome this difficulty. Without marring the appearance of the furniture as is frequently the result when heavy padding is used to insulate the cold metal, the transparent arms are effective in warding off cold shudders while adding materially to the bright, gay atmosphere of the room in which they are used. In addition, these plastic supports are easily cleaned, a damp cloth passed over the surface erasing all signs of dirt.

Table, dresser and bar tops will be made of phenolic laminated plastic, and transparent plastic rods used for railings at the pool and on the stairs. Seat covering on chairs as well as drapery will be made of plastic coated fabrics or fabrics which have been woven from plastic monofilaments.

Plastics might even play a major role in the modernization of bathrooms aboard ships such as the Queen of the Tennessee. Today the width of standard bathroom fixtures presents a weighty problem to ship designers, so much so that they use undersize bathtubs in an effort to conserve weight. And even these tubs weigh several hundred pounds each. Glass-reinforced low-pressure plastics might well be used for these fixtures since they possess the necessary strength and water-resistant properties yet are light in weight. Typical of the

uses to which this material can be put are structure-supporting prefabricated kitchen and bathroom units that are now being planned for the postwar home.[1]

Planned purely as a pleasure vessel, the *Chattanooga* will have no room for freight. However, it will have space for 50 automobiles so that tourists may continue trips to and from the South via highway after a cruise on the Tennessee. Openings similar to those on the bows of LST's (landing ships, tanks) will enable passengers and automobiles to embark and disembark quickly and without trouble. The gangplanks will be operated electrically. The boat's shallow draft of 8 ft. will facilitate loading and unloading at any place along the river regardless of whether elaborate dock facilities are available or not.

## Luxury accommodations

The cruise-liner, 250 ft. long and 50 ft. wide, will be air-conditioned, have a swimming pool, a huge sundeck (165 ft. long and partially covered by an awning), a 100-ft. observation lounge and a clubroom of the same length to accommodate all passengers for dining and dancing. Observation lounges and stateroom verandas will be equipped with tempered glass windows approximately 7 ft. wide, instead of the usual ports. While there will be 8 deluxe staterooms, larger and more luxurious than others, most of the staterooms will have shower baths. Ship-to-shore telephone service will be available in the radio room. A barber shop, beauty parlor, combination shop selling drugs, tobaccos, etc., and motion picture equipment will be included in the accommodations. In fact, nothing has been overlooked which would add to the pleasure of the passengers.

The *SS Chattanooga* is the outgrowth of an idea originated by Emmett S. Newton, prominent Chattanooga civic leader, and the ship's operation will be sponsored by the Tennessee Valley Waterway Conference, Chattanooga Chamber of Commerce and other civic organizations throughout the Tennessee Valley area. The Conference, of which Earl P. Carter is president, successfully sponsored the construction of public use terminals on the Tennessee.

So enthusiastically was the announcement of the first ship received that plans already have been approved for the construction of a second similar vessel. It is also reported that after the war similar craft will operate on other large inland waterways on a basis which will make river travel as popular as it once was on the Ohio, Mississippi and Hudson. But the new ships will have nothing in common with the much smaller side-and stern-wheelers which have played such an important role in river history.

## Postwar yachts

Liberal use of plastics in the postwar yacht is also revealed in another announcement by the Ingalls Shipbuilding Corp. that designs have been completed by George G. Sharp for a streamlined, all-steel and all-welded, fire-proof, 90-ft. luxury ship to be built, along with larger vessels of similar construction, at the Decatur, Ala., shipyard. Present plans call for the use of plastics wherever possible in decoration and trim as well as in furnishings and equipment. In many ways, this smaller vessel lends itself better than the *SS Chattanooga* to the application of these materials.

Having accommodations for 8 passengers, 2 maids, the captain and 4 crew members, the yacht will be powered by two 200-hp. twin-screw Diesel engines and will have a top speed of 15 to 18 miles an hour. Beam will be 21 feet and draft 5 feet. Seaworthy and streamlined, the yacht will be fully equipped with modern conveniences such as air-conditioning, ship-to-shore telephone, short wave radio and television, facilities for showing motion pictures, and bathroom and shower with each stateroom.

The main room for general living and entertaining will be the combination lounge and dining room, 42 ft. long and 19 ft. wide. This room will be luxuriously furnished with every convenience for the comfort and pleasure of the passengers. It will be entirely surrounded by insulated tempered glass windows. The fabrics for the upholstery and drapery will be made of fireproof and mildew-proof glass fabric.

[1] "The hub of the home," MODERN PLASTICS *22*, 118–120 (Oct. 1944).

***2—Included in the plans for these luxury cruisers are a swimming pool, a huge sundeck and observation lounge where a liberal use will be made of plastics for decorations and trim. 3—Such details as dresser knobs, lamps, picture frames and chair arms for use in the staterooms and living quarters will be made of transparently clear plastics***

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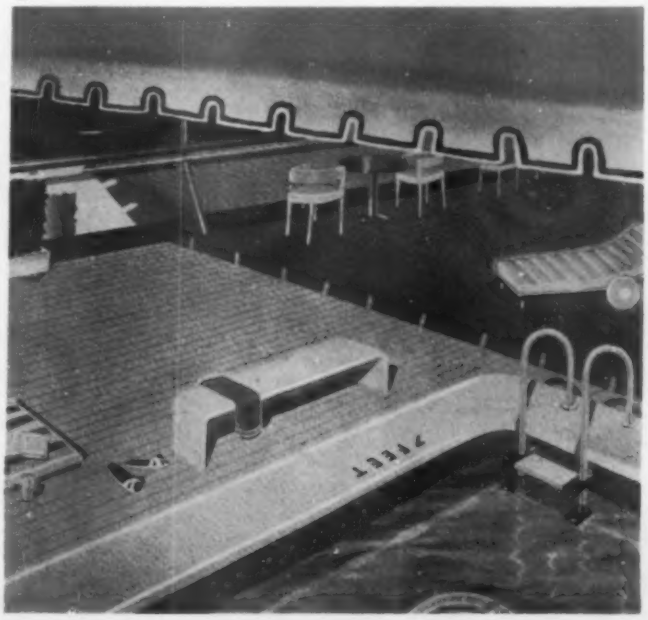

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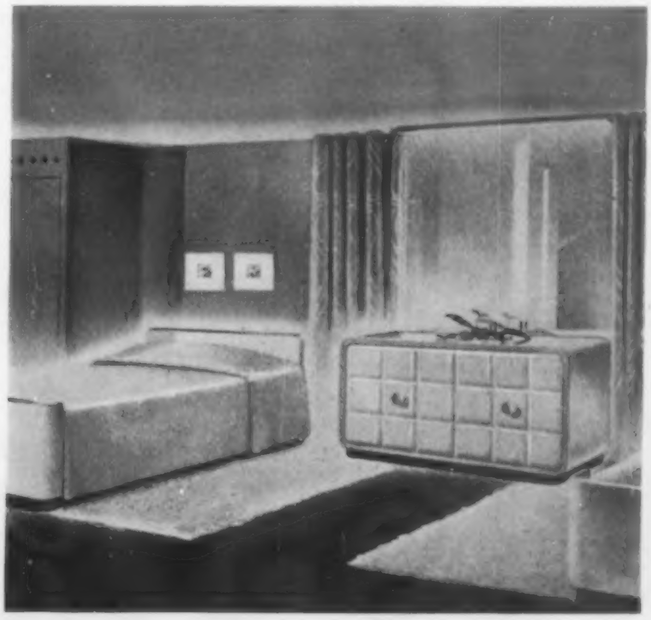

*1—Heels of almost every color are now possible with this new process which injection molds a cellulose acetate coating around a wooden heel core. Dull or glossy finishes add even greater variety to the effects that can be achieved*

# In step with fashion

MILADY'S shoes soon will have what are being called "Lifetime" heels as a result of a new development in injection molding, which automatically covers the wooden heel cores with an evenly distributed coating of cellulose acetate approximately $^1/_{16}$ in. thick.

The process, just patented by a Milwaukee custom molder, is said to impart to heels wearing qualities that far exceed those of any shoe. The new plastic heels will not scratch or scuff, nor will the coating wear off, split or peel, since the plastic material is slightly impregnated into the wood under pressure of injection. There is no seam, and the process can be used for any size, shape or style of heel.

Another important advantage is that the new heels can easily be washed or wiped free of dirt, mud, ice or snow. The coating is not affected by temperature changes or by the action of any elements, according to the results of repeated tests. The heels can be made in either dull or glossy finish in practically every shade of the rainbow, in black, white, brown, simulated alligator, simulated snakeskin, patent leather and, for dress shoes, in any metallic color. Multicolor heels are likewise possible.

Since the plastic is not molded over all of the top or bottom surface of the wooden cores, the heels may be attached to shoes in the usual way, and leather lifts may be tacked on the same as with leather or celluloid-covered heels. The heels are adaptable to all types of shoes—dress, street or work—and, in all cases, the strength of the heels is said to be materially increased.

The adoption of these cellulose acetate coated heels is reported to be under consideration by a number of leading shoe manufacturers. They are said to be competitive in price with celluloid covered heels and far cheaper than leather-covered heels.

In previous attempts to mold a plastic shell or coating about a shaped wooden core, numerous difficulties were encountered, due mainly to the high pressures employed in the injection of the plastic into the mold. These wooden forms or cores are supported in the mold by pins extending into opposed

ends of the core. Thus, when the usual direct feeding methods are employed, the pressure of the molten plastic material as it enters the mold shifts the core on its supporting pins. Often, as a result of this movement, the core is deformed. Equally serious is the uneven application of the coating material to the walls of the core that results from this shift.

In a shoe heel of the coated-core type it is absolutely essential that the wall thicknesses be uniform throughout. Unless this is true the product will be lopsided and unsightly and the final dimensions of the product may vary from those originally contemplated. It is also a fact that if certain molded wall portions of the heel are thicker than required it will take those portions longer to cool, thereby tying up the mold and apparatus for a longer period than that really required. Inasmuch as the molding equipment represents a very substantial investment, this difficulty would increase the cost of production of the articles and hamper the speed of operations.

To overcome these difficulties, this custom molder adopted a type of gating which is a modification of a ring gate. This method of gating makes possible the production of a shoe heel with uniform wall sections of thermoplastic material completely covering the outside portion of the heel. Another object of this patented process is to provide a means of forming molded shoe heels wherein the heel seat is entirely completed within the mold. Thus, when the heel is ejected from the mold it is a completed article save for a few minor finishing operations.

Figure 2 is an enlarged longitudinal sectional view through an improved mold showing the manner in which a wooden heel core is supported therein. The mold is of cylindrical shape, being formed of two separable, complementary sections. One half of the mold is formed with a tapered cavity corresponding in size and shape to the size and shape of a finished shoe heel which is to be formed therein. A circular opening is located at the lower, reduced end of this cavity. After insertion of the wooden core in the mold, a pin is slipped through this opening to hold the small end of the core in position. The complementary mold section is formed at its inner end with an inclined face upon which is located a raised heel-seat forming portion.—This portion is adapted to receive the slightly concave heel-seat section of the wooden core. Two metallic pins which protrude from this part of the mold are located so that they enter apertures in the heel seat of the core, thus lending support and assuring that the core stays in the proper position relative to the mold.

Figure 3 is a view of an enlarged end of one of these molded heels just as it appears upon removal from the mold. It shows clearer than words can describe the horseshoe-shaped channel and three ducts leading therefrom that form the indirect arrangement for feeding the thermoplastic material into the mold. This spaced indirect feeding arrangement provides for simultaneous and uniform flow, under similar pressure conditions, all about the core so that there is no tendency for the core to be shifted on its pin mountings. The molding material is intended to cover all side portions of the heel and flow to the extreme tapered end of the core, covering the small end to some extent. Entire covering of this end is not essential because the heel is completed by the application of a separate tread. The molding material also overlaps the heel-seat end of the core and forms a rim.

The three claims allowed by the patent office are as follows:

1. A cylindrical permanent mold, comprising a pair of endwise separable, complementary, metallic mold sections having complementary faces, only one of the mold sections having an elongated tapered cavity therein; means extending axially of the mold sections for supporting a core within said cavity of one mold section in uniform spaced relation from the side walls surrounding the cavity and against the complementary face of the other mold section; a fluid conducting channel formed within the face of said other mold section following the contour of and extending partially around the periphery of the enlarged end of the mold cavity; a plurality of spaced feeding ducts within said mold section affording separate fluid communications between selected portions of said channel and spaced portions of the mold cavity; and a fluid inlet duct extending into the mold and registering with an intermediate portion of said channel.

2. A permanent mold, comprising a pair of endwise separable, complementary mold (*Please turn to page 206*)

*2—The wooden heel core is supported in the mold by three metallic pins. 3—To insure a uniform flow of material into the mold, the gate is formed in the shape of a horseshoe. This arrangement equalizes the pressure of the material flow and overcomes any tendency for the wooden core to be shifted from a central position on its pin mountings*

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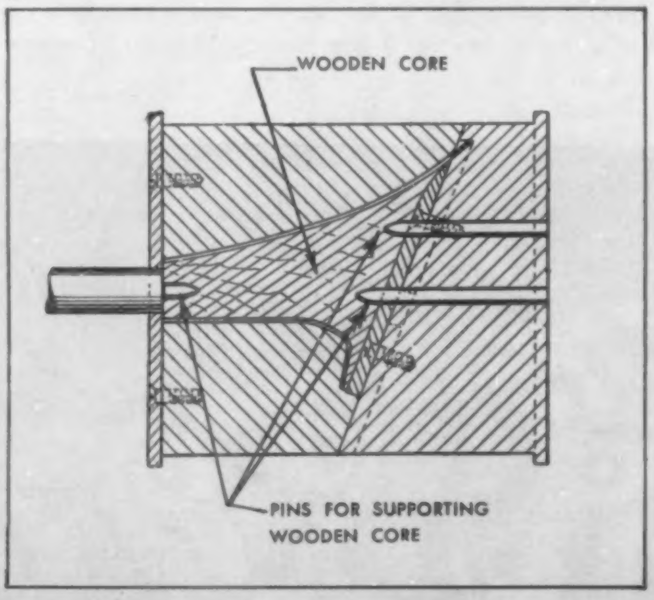
DRAWINGS, COURTESY PERELES BROS., INC.

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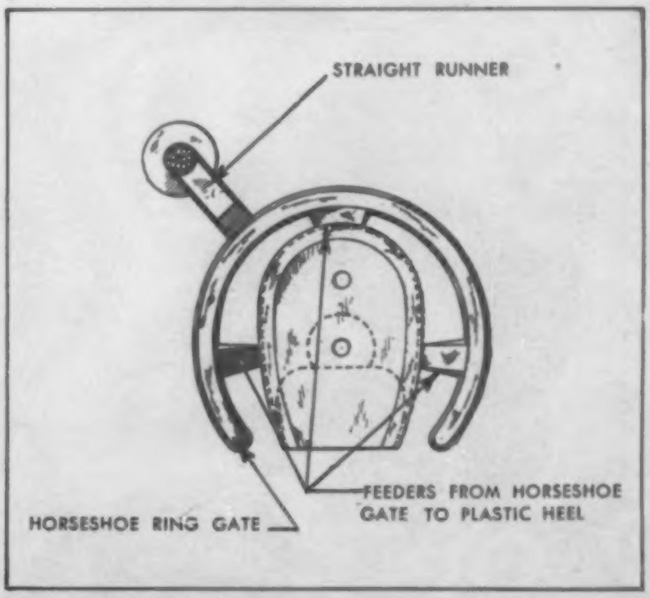

# PLASTICS IN REVIEW

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**1** No matter how hazardous the job, workers are inclined to leave off safety equipment if it is too cumbersome or uncomfortable. Therefore, employers are providing these safety goggles with lightweight shatterproof Tenite frames molded by Vlchek Tool Co. for Kimball Safety Products Co. These goggles, worn by locomotive engineers and firemen and workers in foundries, defense plants and shipyards, provide full protection plus the utmost in comfort. The lenses are removable so that lenses of different colors may be easily inserted if desired

**2** Laboratory equipment, with its rigid requirements of physical stability and chemical resistance, is becoming increasingly dependent upon plastics for its various apparatus. The most recent application is this gable-type cover for serological baths, designed by Precision Scientific Co. and molded by Elmer E. Mills Corp. The unusual design of the cover permits the condensation of moisture to run down the side and drop off into the water bath instead of the test tube as occurred with the old type materials used. The low coefficient heat transfer of this material makes it a good thermal insulator, allowing the maintenance of constant temperature inside the water bath

**3** One of the more recent developments in the field of sound recording is a portable magnetic-wire recorder with a playback device, capable of storing sound indefinitely. The wire on which the sound is recorded is wound on a spool molded of Resinox in a single-cavity mold by Oris Mfg. Co., Inc., for General Electric Co. These spools are held to close tolerance and must resist the pull and tension of almost two miles of wire

**4** An unusual type of power transmission, evolved to prevent gear breakage on revolving turret machinery in the event of jamming, employs Compar rings to mesh with metal gears. These vinyl-derivative rings, developed to replace the rubber rings originally used for this purpose, have a service life five times greater than that of their rubber predecessor. The mate-

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rial is compounded to give the exact degree of flexibility, elasticity and abrasion resistance required for this application

**5** Since it has been universally agreed that cosmetics constitute a vital asset to morale, they must be suitably packaged despite wartime restriction of their normal container materials. This lipstick case is injection molded of Lumarith by Celluplastic Corp. and Plastic Products for Eyelet Specialty Mfg. Co., who handle the case for Daggett and Ramsdell Co. The lipstick operates with gear action to allow for the normal expansion of the material due to weather conditions. The unusual design of the case, which is small for the size of the lipstick which it houses, effects a 60 percent saving in material over that required for regular-sized containers

**6** Designers of office and home furnishings have long since found that transparent plastics lend themselves readily to the most modern design effects while still filling strictly functional uses. This attractive lamp, which was designed by Dorian Studios, is made entirely of Lucite with the exception of two small metal parts: the socket and a small piece of tubing one inch in length. The shade and the section between the base and shade are formed from sheet stock; the base and strips which eliminate seams and contribute to the modern feeling of the design are cut from solid blocks

**7** So that all available space can be utilized to best advantage, plant managers are now employing Plexiglas models to visualize their plant layout and location. Display Studios, who made this model of a synthetic rubber factory for Blaw-Knox Co., find that they can construct the most intricate mechanical models from this material. It can not only be cut to the proper size with ordinary saws but also drilled and machined in the same manner as many soft metals are handled

**8** Thirsty travelers who have gazed longingly at flowing springs without any civilized means at hand for slaking their thirst will be pleased by these collapsible drinking cups which can be carried in a pocket or purse. The cups are molded by Plastic Die and Tool Co. of Tenite II in a two-unit, 10-cavity die. Two complete cups are produced in one molding operation. These brightly colored "Zip-sip" cups, as they are called, are marketed by Plastic Molded Products

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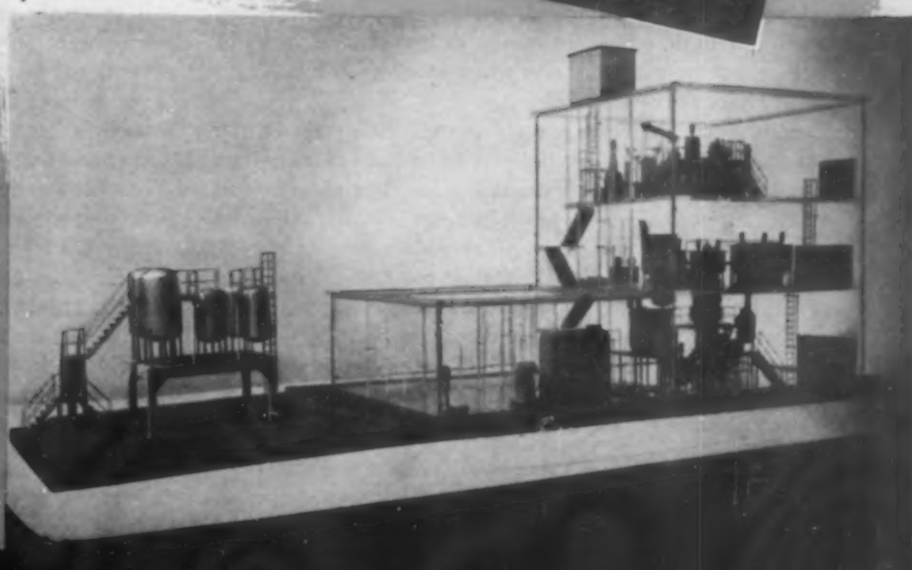


*1 and 2—To overcome danger of leakage that might result from shocks of handling, fragmentation bomb accessories are packed in these plastic surfaced plywood cases. 3—When unpacked, these 4-in-1 boxes are nested for reshipment or used for equipment being sent to a rear base for repairs. 4—A plastic-surfaced ammunition spare parts box*

# Resin impregnated plywood surfacing

THE packaging of the materials of war to insure their safe delivery to the beachheads and fighting fronts all over the world has presented many difficult problems. Cases carrying the more sensitive equipment and demounted guns to the far north are subject to extreme cold, fog and inclement weather, while those shipped to the tropics suffer attack by fungus, mold, termites, extreme heat and humidity.

In order to improve the characteristics of plywood in this difficult service, a line of phenolic resin impregnated papers has been developed for application to the base plywood to form a tough waterproof skin. The resulting product is a material combining many of the desirable qualities of a thermosetting laminate with the high strength and low cost of plywood. A hard, abrasion-resisting surface is provided that has extremely low moisture absorption and water-vapor permeability. The strength characteristics of the base plywood are somewhat improved, particularly the transverse flexural strength. The increase in transverse flexural strength in some cases permits wider spacing of supporting members in construction work.

The surfacing material is impregnated with resin in the paper-making process. Techniques have been worked out that make it possible to cure the thin laminate and bond it to the outer surfaces of the plywood in a single operation in the plywood manufacturer's plant. The economies realized by this process as compared to the former method of producing first a thin laminate and then gluing it to the plywood core, are substantial and bring the price of the resulting plastic-surfaced plywoods within the reach of the mass markets.

The color range of the plastic surfaced plywood now being produced is limited to olive-drab and black to meet the needs of the Armed Services. Research already well advanced assures the production of the material in a wide range of colors to fulfil the demands of a peacetime market and with a variety of resins to meet the needs of specialized end uses.

The phenolic resin impregnated surfacing has to date been used almost entirely for the surfacing of softwood and hardwood plywoods. Since the qualities of low moisture absorption and water-vapor permeability are obtained by application of a thin surface film, with little improvement resulting from a use of thicker films, the bulk of the production of plastic surfaced plywood has been with a surface film 0.009 in. thick, weighing approximately 60 lb. per thousand sq. ft. of surface area.

Table I gives the general properties of the material on the basis of the product produced in quantity to date.

Plywood surfaced with phenolic resin impregnated paper is currently produced for use in export shipping containers with waterproof internal adhesives. As compared with conventional "waterproof" plywoods, these plastic-surfaced plywoods have about one-twentieth the water absorption, extremely low moisture-vapor permeability and a tough, abrasion-resisting surface. Typical of the outstanding work that has been done in designing and producing shipping cases of this plastic surfaced plywood are the various types of boxes shown in Figs. 1, 2, 3 and 4.

Shipping case MK-1 for fragmentation bomb accessories (Figs. 1 and 2) takes the place of a sheet steel-lined wooden box originally used to pack this U. S. Army Ordnance item. This early pack was not entirely satisfactory since under the shocks of handling the metal liner occasionally sprung, permitting water to enter and (*Please turn to page 212*)

# By their lines ye shall know them

by JOSEPHINE von MIKLOS*

ANY time a distinguished designer like T. H. Robsjohn-Gibbings can say something like the following—and get away with it without protest—there is something very wrong somewhere. This is what Mr. Gibbings says in his recently published book, *Good-bye, Mr. Chippendale:*

"As to the plastic millennium which we are told by the chemists is at hand, I had a plastic drinking glass in my bathroom and every time I rinsed my teeth, I felt like drinking out of the top of a thermos bottle at a picnic. I like picnics, but not in my own bathroom.

. . .

"Lately there has been a plastic concocted which looks like clear mint drops, and the furniture manufacturers have turned out some horrors made of it that look like a tart's dream of modernistic. If this is a foretaste of the caskets in which the postwar deceased will set forth to meet their Maker, there ought to be a fine postwar rush on cremation.

" 'Destined to become a popular tableware of the world of tomorrow,' says the Office of War Information, 'are the new improved plastic dishes now being used aboard United States naval vessels and patrol bombers . . . . They are used on all ships smaller than destroyers because the firing of the guns played havoc with the mess crockery in smaller vessels.' Of the cups used on patrol bombers, the OWI says: 'On the cups a deep cup-stand "locks" the cup even to as sharp an angle as 30 degrees.'

"Now while I agree that housewives in Kalamazoo have better crockery coming to them in peacetime, I fail to see what a cup of alpha cellulose filled melamine formaldehyde, shatterproof under gunfire and dive bombing, and 30 degrees tip-proof, has to do with a quiet dish of tea between rubbers in a postwar world.

"No! I think plastics are all very well in their right places, and my idea of the right place is a vacuum cleaner nozzle, a refrigerator part or a telephone. But the golden age of plastic wall coverings and furniture . . . . God forbid!

"The way the decorators, the magazines and the furniture manufacturers feel about it right now, if you let them loose with prefabricated houses and plastics, the result would be magnesium Cape Cod cottages, Georgian villas and French Provincial farmhouses rolling off the prefabricated assembly lines; while out of the plastic molds would come a stream of plastic cobblers' benches, Chippendale piecrust tables and corner cupboards in the colors of the rainbow. And the way the public is being brought up right now, this chemical chow mein would be just its dish.

"Just let me add this and then we can drop the subject. Plastics are wonderful. Prefabricated houses are wonderful. And the postwar world will be full of them if the big corporations get their plans through, which they usually do. But both innovations can and will add further aesthetic horror to our lives unless they are controlled and handled by better brains and better taste than those controlling similar innovations in the prewar days.

"America needs more than the dreams of a plastic millennium as seen by E. I. du Pont de Nemours and Co., Inc., or prefabricated ends of the rainbow as seen by Thurman Arnold and others, if it is to produce better homes for its homeless postwar millions. And the sooner we promote some realistic thinking about this, the better the prospects will be of getting them."

Now, there are all sorts of ways of looking at a blast like this, and the one you choose will obviously depend on where you sit at the moment. However there seems to be a good deal of common sense in my friend Gibbings' words and, at the same time, a great deal of misconception. The common sense part can, perhaps, be boiled down to this: no matter how many plastics there will be and no matter how wonderful they are, they should not be used for everything under the sun for the simple reason that things like wood, glass, metal, stone, cotton and the like are still around and performing. Or perhaps we can put it this way: in some curious manner the public feels that we are headed into a new era where only synthetics exist. The abuse of a medium and the abuse of a word have grown to enormous proportions.

The misconception on the other hand—that producers of plastics are hell-bent on producing molded furniture—cannot altogether be laid on Mr. Gibbings' doorstep. The public has seen plastic furniture, and the makers of the material have evidently never bothered to tell the public that those things were not molded but machined, which makes all the difference in the world so far as mass production goes and, consequently, so far as an economic point of view is concerned. For one reason or another, the word Lucite, for instance, has been so glamorized that the general public seems to feel that the world will be covered with rods and sheets of transparency, clearer than glass. As for plastic dishes and similar items, all we can fairly say about them at this moment is: *if* they turn out to be more practical, better looking and more economical than the same things made of other materials, why shouldn't they be molded of plastics?

It is quite obvious that statements such as those quoted above can do the plastics industry as a whole a good deal of harm. All the high-powered promotion and advertising campaigns of all the biggest plastics concerns in the world cannot and will not make Mr. and Mrs. Average Consumer *like* plastics if there is nothing to like about them beyond the fact that they are said to be amazing.

In addition—and this has, I believe, some definite psychological importance particularly in war time—plastics have come to be thought of as substitutes. Not that the public didn't know plastics before the war. But they have now received new impetus and a dramatic importance which they might not have achieved had it not been for some of the spectacular services they are rendering in war. They have, in some cases, been promoted as substitutes; and it seems logical to assume that the famous ersatz psychology will fly out of the window as soon as normal times are here again and we can have the natural materials to which we were accustomed before.

Still, plastics can do many things that no other materials can do. This is a fact much older than war emergency. Too, they have proved economically sound in an era when the machine takes the place of hands and the chemical retort outdoes and outcreates nature. In a world of mass-pro-

* Industrial designer.

*1—Miss von Miklos has heightened the texture of these acrylic decorative pieces by the addition of a fine pattern to their surface. In this way greater warmth and sparkle is imparted to the plastics*

duction and mass-consumption man has learned to make new materials practically out of thin air. And that, too, is older than the war.

But Mr. Gibbings' little jibe about his bathroom tumbler has been duplicated in parallel statements from many other, not so esoteric, sources. Dozens of women are saying: "I don't like plastics. They're too slippery. They look cheap. There's no *feel* in them."

Perhaps to overcome—or to attempt to overcome—this prejudice, a client of mine recently asked:

"Would you like to design a radio cabinet?"

I said I would love it.

"Make it cream," he said.

"Why cream?" I asked.

"It's to go into bedrooms. Also," he continued, "put some roses on for decoration."

I didn't ask "why roses?" I knew the answer. The idea is that "roses sell." I understood his reasoning all right. Decoration adds to plain surfaces and the famous feminine touch might make a bedroom radio more salable.

Well, maybe roses do sell, and maybe they don't. But it has always seemed like a great pity to me to take a material which holds great intrinsic beauty and slap on it some extraneous decoration. If that "slippery feeling" of plastics is objectionable, as in certain instances it seems to be, then there should be other ways to deal with it than silk-screened roses.

There are still a great many business people who believe that to design things in popular taste, you've got to design them in bad taste. Or perhaps we haven't yet learned to think quite straight in the matter of decoration. Yet it seems so simple to think in some of the basic principles of merchandising and to apply them to design in plastics—and design here does not mean only decoration. Perhaps we could put it this way:

a. A good item is an item that serves an honest and useful purpose.

b. A beautiful item is an item designed in good taste which does not just do acrobatics with aesthetic tricks but relates the appearance of the thing to its purpose.

c. A profitable item is an item which allows for legitimate profit after everything has been put into it to make it the very best, most beautiful and most useful item of its kind.

When we pause today and catch our breath and look at the plastics picture as a whole, however, this is what we see:

1. The manufacturers of molding powders and cast plastics have produced such enormous amounts of their products with so many ramifications in all sorts of directions that they must make people believe that practically everything can and will be made of plastics after the war. Or it may be that, without cooperation on the part of the manufacturers, the public believes that plastics are the panacea for all material problems.

2. The public has probably been oversold and surely undereducated in the meaning of plastics and their proper and feasible use in the general picture of daily living.

3. Designers (and this hurts) have learned a few new words —designers are only human after all—among them "streamlining" and "color in the kitchen," and have proceeded to dream up a world which from the present looks of it promises to be perhaps very healthy but not too comfortable and without much allowance for personal taste.

Women who have had to use plastic lipstick cases during the war are now beginning to scream for the good old brass containers. Some of the substitute plastic compacts haven't worked too well and metal, metal, is the cry far and wide. Plastics have, at the moment, a bad name in some sections of the cosmetics industry, but while plastics men know exactly why, the public doesn't. Yet the truth is very simple and could clarify the situation immeasurably. It has been necessary to use contaminated material and scrap because good materials were going into war applications. The onus for the acceptance of unsatisfactory materials for many articles in the cosmetics field lies neither with the plastics nor with the cosmetics industry, both of which have literally turned themselves inside out to answer the ever-growing demand for merchandise—merchandise at any price, merchandise at whatever quality. What are you going to do with war workers who won't run their drill presses unless they have lipsticks? Or perhaps we should be grateful, after all,

2—The conjunction of highly polished and matte areas enhances the appearance of the plastic surface while rough or patterned planes insure a steady grip on handles and knob

that years of intensive education and promotion have finally resulted in the fact that a woman will buy cosmetics in whatever containers they come.

It is reasonable to assume that high-priced merchandise which, in normal times, usually does not run into millions of units, will, after the war, again be sold in containers whose appearance automatically suggests quality and exclusiveness. Dollar lipsticks will, most likely, again be sold dressed in brass. But they don't have to be. That is, plastics don't have to retire completely into the low-priced fields if some of the things plastics can do and some of the things for which metals are more suitable are combined and fused in new ways. Until the day when we can mold plastics economically to form as thin a wall as can be obtained in brass, we will continue using the brass lipstick swivel, which so far has found no equal in any material. But the caps might be made of plastics in an unlimited range of color and design, thus adding a new kind of dash to that important accessory without which, evidently, no lady is considered fully dressed.

And do we have to remind the public that for years now the bottles they have bought—bottles with all sorts of contents—have been closed by plastic caps? Or that cake powder foundations never were packed in anything but plastics?

But so far as plastic furniture goes, to come back to Mr. Gibbings, the story is a different one. There seems to be, at this moment, very little chance that plastics people are considering molded plastic furniture, although they are doing some thinking in terms of low- and no-pressure resins, and some hunters for all-out novelty ideas will probably bounce on acrylic rods to create more or less eerie effects for individual customers. But mass-production of everyday, every-use plastic furniture? No sir. There is probably no press in the country big enough to hold a multi-cavity mold for a bedstead or a dining room table and, what is more important, produce it at a reasonable price. We'd probably have to make and sell so much plastic furniture to turn it out economically that every home would become a warehouse.

Too, we know that although weight, for instance, is an important factor in shipping, there is in some cases a consumer preference for weight. Weight, at times, seems to impart a feeling of quality and in certain types of merchandise (jewelry for one) we would be foolish to disregard it. In other words, and to make a very long story rather short, manufacturers of plastics can't possibly have the intention of substituting plastics for all other materials unless there is uncontradictable evidence that plastics will give a superior service.

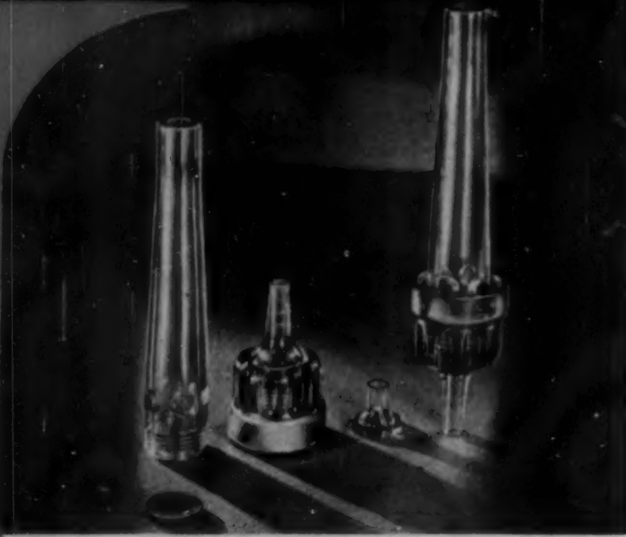
Which is again where design comes in. With profound apology to all those on whose toes we may be stepping, somehow or other, design in and for plastics has stopped with the learning of those few words mentioned before. We have gone overboard for color; we have gone overboard for polish; there is no end to the discussion of how we can print on plastics and metal-plate them and do this trick and that. But we seem to have forgotten completely that the shape of things and their color—and even their practicability and economy of price—do not cover the full range of human needs. We have, in one word, forgotten *feel*. Texture is something we don't think of when we talk of plastics.

Mr. Gibbings' bathroom tumbler would probably never have incurred his wrath if it had had a fine pattern all over its surface which would have taken away the so-called "cheap finish" and permitted it to sit more firmly in his hand.

"Hey," I hear the mold engineers and toolmakers say, "have you any idea how much more patterned molds would cost?"

Yes, I have. We'd have to do some pretty fancy milling and grinding in order to put a knurling pattern, let's say, in the molds for a bathroom tumbler, a toothbrush, or whatever. All right. I am convinced that properly designed texture would open tremendous new fields and avenues of sales because it would bring plastics into a new aesthetic range, a new range of acceptability, if you will. It would bring new scope to the imagination and help develop in a new field that kind of fusion between mechanical perfection and the purposeful application of beauty which is—or should be—the epitome of modern industrial design.

But if the possible price of an item could not stand that kind of suggested super-tool work, there are other things we could do to create a feeling of (*Please turn to page 208*)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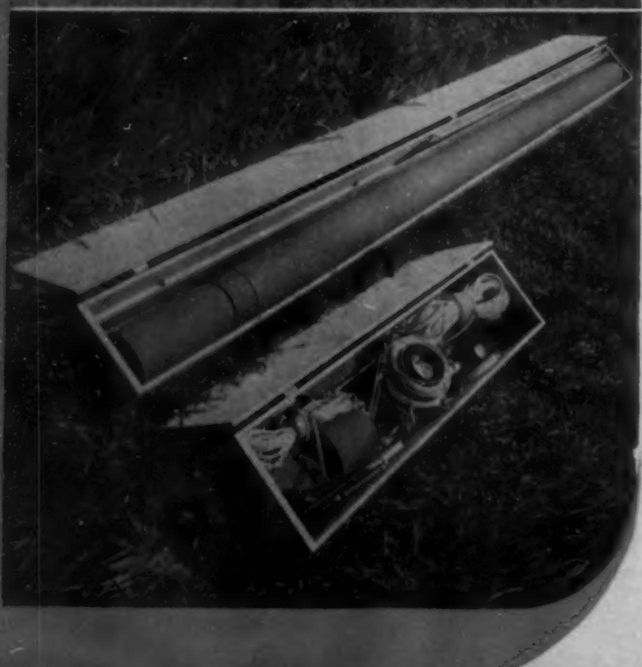
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# PLASTICS

YEARLY, VAST QUANTITIES OF VALUABLE FUEL oils and gasoline are lost in destructive fires. Fire-fighting apparatus equipped with the usual water-directing equipment finds itself helpless in combatting these fires because a hard stream of water tends to spread rather than extinguish the blazing oil. As an aid in controlling the blaze, a chemical air foam has been developed which, when added to the water and pumped from stirrup pumps and pump tanks through specially constructed nozzles, spreads a heavy lather over the burning surface, effectively shutting off air and smothering the blaze.

The nozzle assembly for the dissemination of the foam comprises three different cellulose acetate butyrate parts: nozzle, nozzle cap and valve (Fig. 1). The nozzle and valve mold, which is run in an 8-oz. injection machine, consists of two nozzle cavities and three valve cavities. The core sections of the nozzle, which because of their length have been channeled for direct cooling to prevent the molded parts from sticking, are automatically pulled by a large air cylinder coordinated with the timing clocks on the injection machine. The cap mold, run on a 4-oz. injection machine, consists of two cavities with removable threaded core plates. The caps are removed from the plate with a special unscrewing fixture.

*Credits—Material: Tenite II. Molded by Ideal Plastics Corp. for J. T. Laboratories*

WITH ARMIES TRAVELING ACROSS THE BATTLEfields of the world at unheard of speed, all essential equipment must be reduced to an absolute minimum of weight without any sacrifice of quality or durability so that it can be readily transported along with the troops. This is especially true of Signal Corps equipment with its complex array of radio towers and antenna masts which must be set up temporarily and yet provide the necessary stability of a permanent structure.

For this reason radio antenna masts, such as the one illustrated (Fig. 2) which is 50 ft. in height, are being made of plywood sections which can be dismantled and nested in a compact fitting box. These masts are formed of thin layers of wood veneer impregnated with urea-formaldehyde resin by a special process. After impregnation the layers are wrapped spirally on a mandrel in such a manner that in some cases the veneers are parallel to the axis of the tube and in other cases they are + and −45° to the axis. This three-phase construction is said to give the tube a strength approximating the ultimate strength of wood.

The fittings chest for the mast (Fig. 3) is approximately 4 ft. long by 10 in. square and weighs about 150 lb. packed. The anchor rods are shipped with the mast in a box $6^1/_2$ in. by 8 in. by 11 ft., weighing also about 150 pounds. The combined weight of the boxes is considerably lighter than that of equipment previously employed, and the telescoping of the long shaft made possible by the sectioning of its length is a further advantage in its transportation.

*Credits—Material: Plytube. Fabricated by Plymold Corp. for U. S. Army Signal Corps*

# PRODUCTS*

THE FIRST INJECTION MOLDED PLASTIC SEXtant has joined the parade of war-born plastics products with unusual peacetime possibilities. As every seaman knows, the sextant is used for measuring angular distances, and for observing altitudes so as to determine latitudes and longitudes. It also is used to measure lateral angles from the shore line, and to determine the distance to the shore.

Designed and produced for the U. S. Maritime Commission, the all-plastic sextant (Fig. 4) is for use on life boats and has features incorporated in the most expensive metal sextants. It does not have the usual small micrometer adjustment. Accurate to one minute of a degree, the product is built on lines similar to those of metal sextants, and has the additional advantages of economy, speed of production and light weight. Practically all metal sextants are of brass and bronze with the calibrations individually engraved. Consequently they not only are costly but slow to manufacture.

All in all, this new sextant has 18 plastic parts (Fig. 5); 9 precision dies are used in the molding. A two-piece retractable handle which saves space is a new feature. Other plastic parts are used in the measuring arm, frame, sight tube assembly, horizon mirror assembly and index mirror assembly. There are two sets of filters for the two mirrors, the filters being used to compensate for varying positions of the sun and varying weather conditions, depending on intensity of light and glare. Provision is made for adjusting the mountings of both mirrors, this being of value in short sighting.

*Credits—Material: High-temperature Lucite. Molded by Cruver Mfg. Co.*

CONSCIOUS OF THE FACT THAT THEK EYNOTE OF modern airplane design is the essence of comfort and convenience through the elimination of unnecessary detail, airline companies have expressed this awareness in the furnishings of their offices and terminals. Recent developments in functional and decorative plastic materials have found ready acceptance here.

Examples of plastic materials used in United Air Lines' offices include counter facings, ticket counter tops and tops of tables and counters (Fig. 6) where transparent covers are desirable so that time tables and other printed matter can be placed underneath for ready reference.

The conventional polished walnut counter facings are replaced by an inexpensive chromium-gray pyroxylin-coated fabric, which is impervious to scratch and easy to clean. The material, which resembles the metal side of a Mainliner plane, is reinforced by padding to absorb shock, and held in place by chromium upholstery nails which help to carry out the aeronautical motif.

Tops of newly-designed ticket counters are covered by a plastic-coated material which has both color and pattern impregnated in the material. This material has the advantage of being cigarette proof and stain resistant and requires neither waxing nor polishing.

*Credits—Materials: Counter facings, Rocoteen; ticket counter tops, Marlite. Used by United Air Lines*

* Reg. U. S. Patent Office.

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# Silicones—high polymeric substances

by SHAILER L. BASS,[1] J. F. HYDE,[2] E. C. BRITTON[3] and R. R. McGREGOR[4]

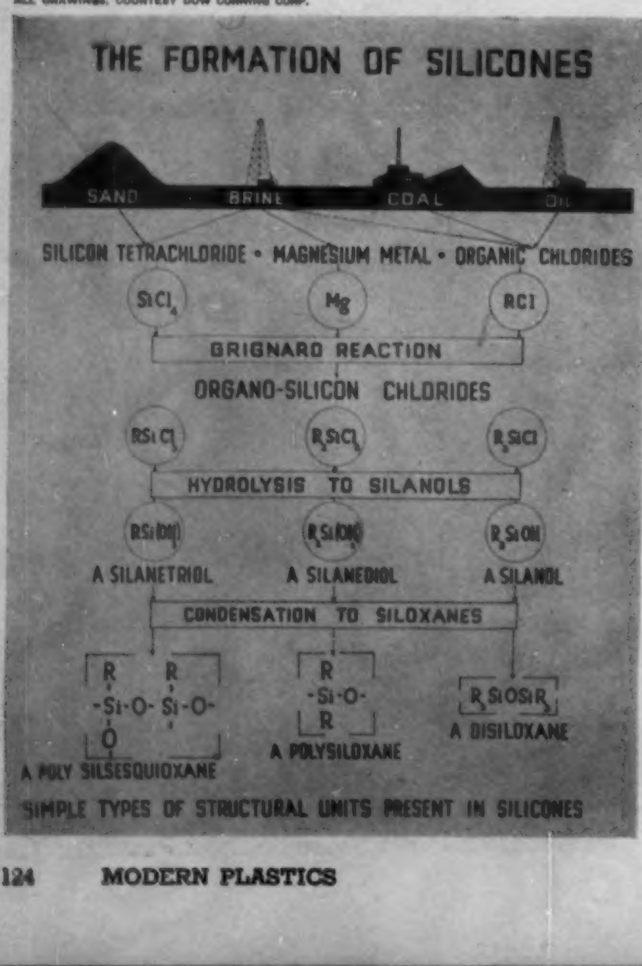
FIRST commercial production of "silicones," an entirely unique, perhaps even revolutionary, class of high polymeric substances, was announced during the past few months.[5, 6] These new heat-stable organo-silicon oxide polymers are now available in several physical forms. They include fluids[7] for use over a wide temperature range with little change in viscosity, chemically resistant greases,[8] insulating resins[9] and high-temperature lubricants. These new silicone materials are characterized by their stability to heat, their inertness to water and chemicals, and their excellent dielectric properties. Silicones in many other forms of more direct interest to the plastics industry are under development.

In general, silicones extend the range of service temperatures well beyond the limit of thermal stability of conventional organic products. Their heat stability, inertness and electrical properties are, in large part, due to the fact that they are built upon frameworks of silicon atoms joined to each other only through oxygen atoms. This silicon-oxygen-silicon structure was previously known in high polymeric materials only in the completely inorganic high polymers, such as quartz, vitreous silica, glass, asbestos and other mineral silicates.[10,11]

[1] Dow Corning Corp.
[2] Corning Glass Works.
[3] Dow Chemical Co.
[4] Senior Fellow, Mellon Institute.
[5] Chem. and Eng. News *22*, 1134 (1944).
[6] Chem. & Met. Eng. *51*, 66, 138 (1944).
[7] "Dow Corning Fluids."
[8] "Dow Corning Plug Cock Grease."
[9] "Dow Corning Resins."
[10] H. Moore, Chem. & Ind. *58*, 1027–37 (1939).
[11] K. H. Meyer, High Polymer Series, *4*, 75–90 (1942).

**1**—*The derivation of silicones from ultimate sources*

ALL DRAWINGS, COURTESY DOW CORNING CORP.




## Background and development

Silicones as a new class of high polymeric materials came into being as the result of research[12] in the field of polymer chemistry, bounded by the glasses and silicates on the one hand and by the organic plastics on the other. Interest in this field was stimulated to some extent by the advent of glass-clear plastics and by the thought that organo-silicon-oxygen derivatives might help to point analogies to structures in glass or at least might provide materials useful with glass.

The commercial development of continuous glass filaments[13, 14] for electrical insulation provided an added stimulus. Insulating resins and varnishes of a higher order of heat resistance were needed to fill voids and keep out moisture if the advantages of glass-fiber insulation were to be realized. It soon became apparent that only the class of resins now called silicones had the requisite heat resistance to be natural complements to Fiberglas in electrical insulation. Attention was called to this fact by Hyde[15] and Rochow[16] in this country, and by Andrianov[17] and Koton[18] abroad.

Silicones are truly a product of the twentieth century. They are indebted to the chemical researches of Kipping over the period from the century's turn up to the present time for a considerable background of information on their "monomers" and low molecular weight condensation products. Kipping concluded after 37 years of research on the simpler organo-silicon compounds as analogues of carbon compounds that the prospect of any immediate and important advance in this section of organic chemistry did not seem very hopeful.[19]

However, the industrial growth and knowledge of organic high polymers that followed the last war and the exigencies of the present war have stimulated research and industrial development in the high polymer aspects of silico-organic chemistry. As this chemistry unfolds and the manufacture of silicone materials progresses, industry will receive a host of new and unusual products including plastics, elastomers, coatings and oils—all characterized by heat stability beyond the limit of organic materials in the same physical forms.

## Formation of silicones

Silicones may be said to derive ultimately from sand, brine, coal and oil. However, like the organic plastics which are said to come from coal, air and water, their synthesis involves a number of steps and a considerable amount of industrial and chemical technology.

Although the basic elements of silicones are silicon and oxygen, the two most abundant elements in the earth's crust, the silicon atoms must also carry one or more hydrocarbon groups joined to the silicon through carbon. This provides solubility of the intermediate condensation products in organic solvents and promotes flexibility in the more or less completely condensed resins. The kind and number of such groups attached to the silicon atom play an important part in the properties of the finished silicones. This will be apparent

[12] Under the direction of Dr. E. C. Sullivan, Corning Glass Works.
[13] Games Slayter, J. Am. Ceram. Soc. *19*, 335 (1936).
[14] J. H. Plummer, Ind. Eng. Chem. *30*, 726 (1938).
[15] J. F. Hyde and R. C. DeLong, J. A. C. S. *63*, 1194 (1941).
[16] E. G. Rochow and W. F. Gilliam, ibid. *63*, 798 (1941).
[17] K. A. Andrianov, J. Ind. Org. Chem. (U. S. S. R.) *6*, 203–7 (1939).
[18] M. M. Koton, J. Appl. Chem. (U. S. S. R.) *12*, 1435–9 (1939).
[19] F. S. Kipping, Proc. Roy. Soc. *159A*, 130–47 (1937).

Table I.—Physical Properties of Liquid Silicones

| | Viscosity grade in centistokes 25° C. | Flash point minimum | | Equilibrium melting point | | Specific gravity 25° C./25° C. | Refractive index at 25° C. | Expansion coefficient $C \times 10^3$ per ° C. | Boiling point | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ° C. | ° F. | ° C. | ° F. | | | (25° to 100° C.) | Temp. ° C. | Press mm. Hg. |
| Type 500 | 0.65 | −1 | 30 | −68 | −90 | 0.7606 | 1.3748 | 1.598 | 99 | 760 |
| Type 500 | 1.0 | 38 | 100 | −86 | −123 | 0.8182 | 1.3822 | 1.451 | 152 | 760 |
| Type 500 | 1.5 | 71 | 160 | −76 | −105 | 0.8516 | 1.3872 | 1.312 | 192 | 760 |
| Type 500 | 2.0 | 91 | 195 | −84 | −119 | 0.8710 | 1.3902 | 1.247 | 230 | 760 |
| Type 500 | 3.0 | 107 | 225 | −70 | −94 | 0.896 | 1.394 | 1.170 | 70–100 | 0.5 |
| Type 500 | 5.0 | 132 | 270 | −70 | −94 | 0.918 | 1.397 | 1.095 | 120–160 | 0.5 |
| Type 500 | 10.0 | 177 | 350 | −67 | −88 | 0.940 | 1.399 | 1.035 | * | * |
| Type 500 | 20.0 | 271 | 520 | −60 | −76 | 0.950 | 1.400 | 1.025 | * | * |
| Type 500 | 50.0 | 282 | 540 | −55 | −67 | 0.955 | 1.402 | 1.000 | * | * |
| Type 200 | 100.0 | 315 | 600 | −55 | −67 | 0.966 | 1.403 | 0.994 | * | * |
| Type 200 | 200.0 | 324 | 615 | −40 | −40 | 0.971 | 1.403 | 0.968 | * | * |
| Type 200 | 350.0 | 329 | 625 | −40 | −40 | 0.972 | 1.403 | 0.966 | * | * |
| Type 200 | 500.0 | 329 | 625 | −40 | −40 | 0.972 | 1.403 | 0.965 | * | * |
| Type 200 | 1000.0 | 338 | 640 | −40 | −40 | 0.973 | 1.4035 | 0.963 | * | * |

* Non-volatile at 200° C. and 0.5 mm. mercury.

from the schematic representation of their formation from ultimate sources (Fig. 1).

The first step of Fig. 1 shows the replacement of one or more chlorine atoms attached to silicon by organic radicals through the use of magnesium metal in the form of Grignard reagent. This reaction, discovered by Kipping[20] in 1904, allows wide choice of groups and permits considerable versatility in tailoring the properties of silicones to specific uses. The organosilicon chlorides are then treated with water to replace the remaining chlorine atoms with hydroxyl groups. Condensation of the hydroxy organo-silanes, or silanols, follows to build up high polymeric units except in the case of the trisubstituted silanol which can condense only once to form a disiloxane, the silicon analogue of simple ethers.

The silanols may be said to be the "monomers," although they usually condense as fast as formed under the conditions of hydrolysis. Silanediols, having two of the four valences of the silicon atom blocked with organic groups, can condense in only two directions. Silanetriols, having only one valence occupied by an inert group, can build up polymers in three dimensions. Hydrolysis and condensation of the variously substituted chloro-silanes can thus give rise to an infinite variety of high polymeric products,[21, 22] varying from liquids through thermoplastic solids to glass-like resins.

## Liquid silicones

During the search for glass-like silicone polymers, a series of water-white, odorless, inert liquid silicones was discovered and was one of the first families of silicone polymers to reach commercial production.[7] Before the war, these new liquid silicones were laboratory curiosities chiefly interesting for their unusual combination of properties. They have since demonstrated their utility over conventional organic liquids in many engineering and technical applications. A wide range of viscosity types is available, the physical properties of which are listed in Table I.

These new liquid silicones are further characterized by:

1. Water-white, brilliantly clear, mobile liquids which remain fluid at arctic temperatures.
2. Unusually low rate of viscosity change over a wide temperature range.
3. Stable to heat, neutral in reaction, chemically inert and noncorrosive to metals.
4. Higher flash points than petroleum oils of equivalent viscosity.
5. Readily wet clean, dry surfaces of glass, ceramics and metals, thereby making them water repellent.
6. Highly resistant to oxygen, oxidizing agents, mineral acids and corrosive salt solutions.
7. Incompatible with synthetic rubber polymers and the polymers used in organic plastics.
8. Insoluble in water and the lower primary aliphatic alcohols; soluble in most organic solvents.
9. Nonvolatile, except for low viscosity grades. Weight loss and vapor pressure negligible up to 400° F.
10. Low dielectric constant and power factor over a wide frequency range.

One of the most interesting properties of these new liquid silicones is their unusually low rate of change in viscosity with temperature as compared to petroleum oils of equivalent viscosity. This is shown by the curves of Fig. 2 for the viscosity grades listed in Table I.

## Uses

The two families of silicone liquids listed in Table I are useful wherever there is a need for a liquid with a lower rate of change of viscosity with temperature than previously available oils possess, retention of fluidity at low temperatures, or practical nonvolatility at elevated temperatures. These properties, together with the liquids' inertness toward metals, coatings and gasketing materials, indicate these new silicone fluids for use as damping fluids, gage fluids and dashpot liquids. Because of their exceptional resistance to chemicals, they have also proved useful as impregnants for asbestos packing and gaskets in chemical pumps.

The new silicone liquids are nonsolvents for other high polymeric materials used in plastics even at elevated temperatures. For this reason, they are useful mold release agents, particularly in the injection molding of hollow articles. When so used, they produce a water-repellent surface on the molded plastic which has greatly increased surface resistivity. Although the liquid silicones are insoluble in water, they do

[20] F. S. Kipping, J. Chem. Soc. *91*, 209–40 (1907); Proc. Chem. Soc., *20*, 15 (1904).
[21] Brit. Pat. 561,136 and 561,266 (1944) to Corning Glass Works. Also many U. S. patents pending by Corning Glass Works assignees.
[22] U. S. Patents, 2,258,218, 2,258,219, 2,258,220, 2,258,221, 2,258,222, 2,286,763 to General Electric Co.

not prevent transpiration of moisture to the treated article.

The silicone fluids are also indicated for use as liquid dielectrics, because of their extremely low power loss, low water absorption and stability to heat. Their solutions in chlorinated solvents may be used in treating the surfaces of glass and ceramic insulating forms to render them water repellent and to increase their surface resistivity.[23]

Exposure of various materials to the vapors of organo-silicon halides such as methyl chlorosilanes can also be used to develop a water-repellent film of silicone on the surface.[24] The vapor of the chlorosilane reacts with adsorbed moisture on the surface to be treated, forming a silicone layer as indicated by the reactions in Fig. 1. Ceramic articles to be treated are preferably preconditioned at 50 to 90 percent relative humidity, exposed a few minutes to the vapors of the chlorosilane and the treated articles, then aired to allow the by-produced hydrochloric acid to volatilize.[25] Treated surfaces show a high angle of contact for water droplets. Moisture does not condense on such a surface as a continuous film but as tiny isolated droplets. The electrical resistance of surfaces so treated remains high even under humid conditions.

#### Insulating resins

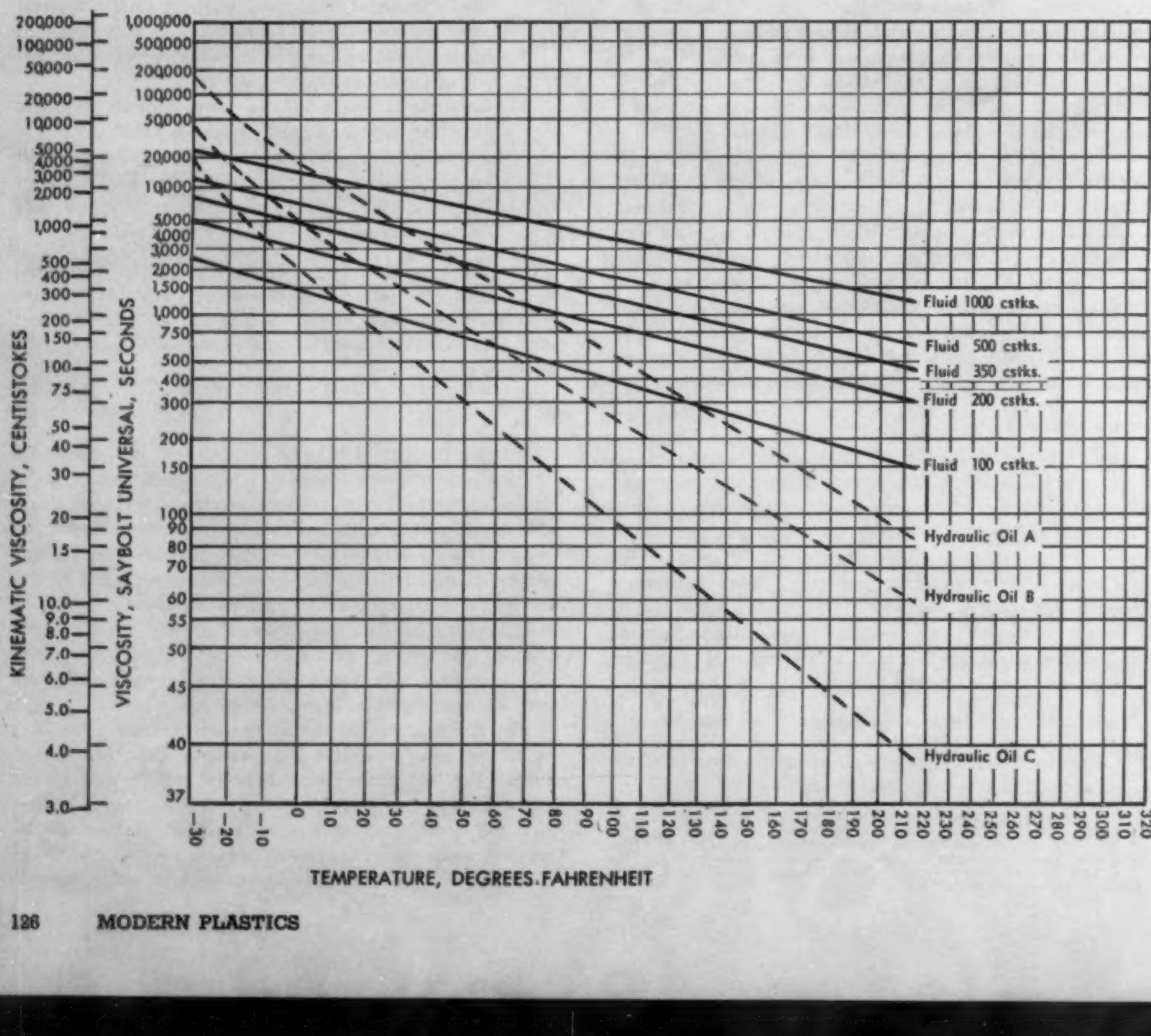
The life of electrical equipment depends primarily upon the insulating and spacing material used. The insulation should be able to withstand any temperature or exposure condition which the equipment is likely to meet, whether at normal or overload operation. In a great many environments, the essential purpose of the insulation is to keep out water. Many impregnating resins and varnishes will exclude water as long as they are not subjected to excessive thermal conditions. Due to the inherent instability of conventional organic insulating materials to heat, they eventually undergo thermal breakdown and become cracked or carbonized, thereby admitting water and conducting materials.

Electrical equipment can be designed and built to withstand high temperatures by using inorganic spacing materials such as glass fibers, asbestos and mica. However, such machines require temperature-stable resinous dielectrics to fill in voids hold the conductors in place, insure good heat conductivity and keep out moisture. Silicone resins now available provide the heat-stable resinous dielectrics which are required in the following insulation constructions:

1. As an impregnant, coating and binder for glass fiber served magnet wire.
2. As a varnish for impregnating and coating glass fiber or asbestos cloth, tape and sleeving.
3. As an adhesive for bonding mica laminations to glass fibers or to asbestos cloth for use as ground insulation.
4. As an impregnating and sealing varnish for filling remaining voids and for completely waterproofing the assembled machine. (*Please turn to page 212*)

[23] "The Dow Corning Liquid Silicone Process for Waterproofing Ceramics," Dow Corning Corp. (October 1944).
[24] U. S. 2,306,222, W. I. Patnode to General Electric Co. (1942).
[25] F. J. Norton, General Electric Review 47, No. 8 (1944).

**2**—*This graph presents the viscosity temperature slopes of company fluids*



PRESS ASSOCIATION INC. PHOTO

*1—The U. S. Army's P-47 Thunderbolt is now armed with six 10-ft. rocket launching tubes, mounted in clusters of three. The tubes are arranged so that they can be fired singly, in groups of three or as a salvo of both clusters*

# Rocket launching tubes

ON August 25, 1944, a headline appeared on the first page of "Republic Aviation News," house organ of the Republic Aviation Corp., which read as follows:

NORMANDY DRIVE LED BY TANK-BUSTING P-47s

ROCKETS SPELL DOOM FOR NAZI ONSLAUGHT

Up until this time, various rumors had pointed to the fact that aircraft such as the P-47 Thunderbolts, P-38 Lightnings, P-39 Airacobras and P-51 Mustangs had been successfully firing rockets. This development, which in the last few weeks has become public knowledge, stemmed from unsuccessful experimental work, launched over a year ago to replace the metal tube of the infantry bazooka by tubes of spiral wound plywood. About the same time, development engineers of U. S. Army Ordnance were attempting to produce what is now known as the "flying bazooka." Basically, this equipment is a 10-ft. tube which has an inside diameter of $4^1/_2$ inches. An attempt was made to produce satisfactory tubes from steel, but great difficulty was experienced in procuring the proper grade. Even when this grade was finally procured, the tube was never entirely successful. Naturally, a great deal of development work had to be done, not only in the tube but also in the projectile or rocket. And it was in this development work that the steel tube showed its weaknesses.

The rocket is made in two basic parts—the warhead or explosive section, and the motor or propelling unit—which are held together by a threaded union. Due to the speed with which these rockets had to be procured and also to a tragic inability to obtain proper gages, the company manufacturing the rockets was unable to hold the necessary close tolerances,

* Reg. U. S. Patent Office.

which resulted in a poor fit between the warhead and propelling sections. Since the female threaded portion of this assembly was a natural weak point, it had a tendency to spread just as the rocket was fired. When this occurred, the two halves of the rocket separated—the warhead bursting from the muzzle end of the tube and the motor shooting out at the breech. However, before the two parts got free of the tube, a terrific internal pressure was set up in the tube. In the case of the steel tube, this pressure became so great that, before the two halves of the rocket emerged into the open, the tube shattered into thousands of pieces, scattering shrapnel all over the testing area. This behavior was due to the very high tensile strength of the steel which prevented the tube from shattering until the pressure had built up to a dangerous degree.

Another drawback to the steel tube was its weight. Magnesium was used at that time—as it still is to some extent—for the body of the rocket launcher. The company's engineers state that although magnesium makes a good tube, a zinc chromate primer is necessary to protect the magnesium from weathering and pitting. In addition, all electrical connections on the firing mechanisms must be carefully insulated. It is probable, however, that the chief drawbacks to the use of magnesium for this application are the susceptibility of the material to corrosion and the greater weight of the magnesium tube as compared to the plastic tube now in use. Another factor mitigating against the use of magnesium at that time was the fairly limited supply of that metal which was available and the request of Ordnance engineers that an urgent search be made for a replacement.

As has happened so many times during this war when the Armed Forces have requested a plastics company to substitute one of their materials for a metal, the plastic material has proved to be not a substitute but a replacement with genuine advantages. Laminating companies have been winding tubes of resin impregnated paper for many years. As a matter of fact, one large Cincinnati Company has manufactured millions of burster tubes by this process.[1] However, the actual operation of rolling a tube of the diameter and length required, light enough in weight yet with sufficient strength to withstand the required stresses, on a scale of production unheard of up until this time, called for completely undeveloped techniques. These were brought to a successful conclusion by the plastics divisions of General Electric Co.

After all tests had been passed, Boston Ordnance requested that facilities be arranged for very high production of the completed unit. At the time, the plant at which these experiments were being carried on had only one or two small rolling machines, and did not have the required space to undertake this job. However, Boston Ordnance had cut back the production requirements on Remington Repeating Arms' shell loading plant in Lowell, Mass.—releasing valuable factory space and a great many new workers. Through the cooperation of Boston Ordnance, Remington Repeating Arms and executives of the company doing the molding, a decision was made to install the immense amount of equipment necessary for the production of this tube in the now empty Remington plant and thus put back to work the labor which had been released. Fifty large tube rolling machines specially designed for this job were built by two manufacturers of molding

[1] "Laminated bomb burster tube," MODERN PLASTICS *21*, 119–23 (Feb. 1944).

PRESS ASSOCIATION, INC. PHOTO

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PHOTOS 3-7, U. S. SIGNAL CORPS

4


***2**—The tubes which have an inside diameter of 4 1/2 in. are mounted on the underside of the wings. **3**—The preheated mandrel is given an initial wrap of two turns of impregnated paper. This core paper provides a good start for the rolling. **4**—The balance of the paper is not impregnated until the instant of rolling. Resin fed from an overhead spout forms a lake over the entire width of the paper just ahead of the rolls*

machinery. Forty-eight were sent to Lowell, and two were set up in Pittsfield. In May, 1944, a number of company engineers, trained in the production of the infantry bazooka, were transferred from Bridgeport to Lowell to undertake the difficult job of training unskilled help in a job which required highly trained labor.

Beginning work at the start of the summer, one of the first problems the engineers faced was that of dermatitis. It was necessary to dress the workers in special cover-alls, aprons, gloves and sleeve guards, and a special type of short boot was developed to protect the feet and ankles. Further, all the help were forced to take showers before and after each shift. To make this possible, two locker rooms were installed. Upon entering the plant at the beginning of a shift, the workers undressed in the "outside" locker room. Leaving all of their street clothes in a personal locker, they passed through a shower room so constructed that it was impossible for an employee to enter the working area without having come in contact with at least a minimum of water. The workers then passed into the second or "work" locker room where all necessary work clothes were made available. These clothes were washed after each shift. Quitting work at the end of the day, the employees went through the same procedure but in reverse.

This skin disease problem was but one of many. For instance, a high labor turnover made the training much more difficult. Nevertheless, on June 7, 1944, the plant shipped its first carload of rocket launching tubes to the Army Air Forces. This record is sufficient testimony of the success of the undertaking.

As stated before, the actual rolling operation is the same as normal tube rolling except for certain necessary refinements in technique. The very large mandrels required by these 10-in. tubes are centrifugally cast of cast iron and then chrome plated.

**5**—*Mounted on frames, the mandrels and tubes are heated in an oven for about 6 1/2 hr. Turned from a vertical to a horizontal position upon removal from the oven, but still on the same frames, the tubes and mandrels are moved into position before the strippers.* **6**—*The stripping device is designed to hold back the rolled tube while permitting the withdrawal of the mandrel.* **7**—*Tubes are ground to correct size by centerless grinders*

5

In the rolling operation, the mandrels are first preheated in an oven. They arrive at this oven on a conveyor and are transferred by an electrical hoist to the oven entrance. Inside the oven there are two large star wheels, on either end, that rotate at a very slow speed. The mandrels are placed horizontally between these wheels with each end resting in a slot in its respective star wheel. As the wheels rotate the mandrels are carried around the oven so that each rod is preheated for a period ranging up to 30 minutes. Finally the rotation of the star wheels carries the mandrels to the point of exit from the oven which is directly above another automatic conveyor. The mandrels drop from the star wheels to the conveyor and are carried along to position in front of one of the rolling machines. There are eight lines of six rolling machines, and one oven is capable of preheating the mandrels for each line.

The preheated mandrel is picked up by an electric hoist as shown in Fig. 3. While held in this elevated position, about two turns of impregnated paper are wrapped around it. This initial wrap is known as core paper and is used mainly as a basis for a good start in the rolling. Due to the heat of the mandrel, this core paper adheres very well. The mandrel is then placed in position in the rolling machine. The two pressure rollers, shown in an elevated position in Fig. 3, are lowered into place, and untreated or uncoated paper is fed into the machine.

After one or two turns of the mandrel, liquid phenolic resin is poured on to the surface of the (*Please turn to page 204*)

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*Molded by Bridgeport Moulded Products, Inc., Bridgeport, Conn.*

# PLASKON

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# Thermo-elastic forming of laminates

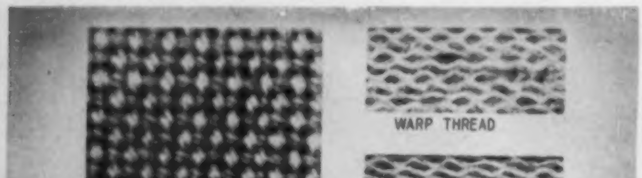
by W. I. BEACH*

ALTHOUGH the thermo-elastic (post-forming) method of shaping flat laminated sheet material falls in the category of low-pressure molding, it differs considerably from the conventional methods—largely in production techniques. In practice, the post forming of fully cured C-stage thermosetting laminates is akin to metal forming. Like metal, laminated sheets are stretched or deformed by externally applied forces. Interchangeability of the forming dies and tools are frequently possible, although it is not practical to do so in view of a novel and unique form of die, devised especially for the thermo-elastic process, which permits the operation of simple inexpensive die elements in any desired plane. On the other hand, low-pressure molding procedures consist of the tailoring and laying up of B-stage resin-impregnated fabrics on or in male and female die arrangements, followed by curing under moderate pressure and temperature. Maintenance of surface conditions and section tolerances necessitates more rigid control in the case of low-pressure molding than in that of post-forming, which is accomplished with stabilized high-pressure-assembled laminated sheet material.

* Plastics engineer, North American Aviation, Inc.

1—*Stretch specimen denoting the alignment of threads*

ALL PHOTOS, COURTESY NORTH AMERICAN AVIATION, INC.




According to the polymerization theory, a chemical reaction occurs during the curing process to formulate a new compound composed of large complex molecules. As is considered characteristic of thermosetting resins, the molecules group themselves into lattice-like, 3-dimensional structures held rigidly together by cross-linking bonds. Hence, when strong intermolecular forces of attraction prevail, the resin possesses thermosetting properties, that is, resistance to deformation by heat, and swelling by solvents. An interpretation of this theory insofar as it pertains to the *irreversibility* aspect of heat-hardening resinous materials leads to some confusion and misgivings. The present method of softening and subsequent shaping of commercial laminated sheet material contradicts the generalization that thermosetting products when properly cured are not subject to reshaping influences. Much information uncovered by investigation of the formability of available thermosetting laminates impregnated with conventional as well as modified types of resin, has succeeded in throwing some light upon the subject. This investigation, dealing primarily with the handling and forming characteristics of laminated stock, revealed:

1. The desirability of always avoiding the use of undercured material.
2. All thermosetting laminates investigated deformed at their critical softening temperature irrespective of degree of cure.
3. Optimum formability and maximum retention of physical properties depend largely upon judicious selection of filler material.
4. General behavior and adaptability of laminates to forming techniques and tools.

## Undercured forming sheet

In far too many instances, the desired softness of the resinous binder has been overemphasized to the extent that undercured laminates are frequently used for forming and drawing requirements. Normally, undercured products serve these needs no better than fully cured and, in some cases, overcured sheets. Attempts to use undercured sheets, in the belief that full and complete cure would be achieved in the forming operation, have proved unsatisfactory from the standpoint of stability and rigidity. Improperly cured laminates tend to produce inferior formed parts because of delaminating characteristics, insufficient shape-retaining stiffness, poor resistance to dimensional changes and questionable physical properties.

## Normal and overcured forming stock

Thermosetting laminates are susceptible to heat-deforming forces throughout their entire useful range. Various tests conducted with overcured specimens subjected to temperatures and pressures exceeding normal curing conditions by several hundred percent, retained satisfactory formability. Evidence of softening properties was discovered in these materials, consisting of different types of resinous binder, up to the end product, at which point structural breakdown and decomposition of resin took place. Likewise, the behavior of all specimens gave rise to the speculation that very little dif-

ference actually exists in the molecular structure of normal-cured and extreme overcured samples. Outside of an increasing tendency toward brittleness, caused no doubt by dehydration of the resin and fabric filler and other causes, overcured laminates are capable of good performance although they are somewhat restricted to larger bend radii and generous curved shapes.

With certain polymerization-condensation resins such as phenol, plasticized or unplasticized, a flat laminated section may be exposed to a heating medium at or above its curing temperature, softened and bent to a minimum bend radii equal to its thickness for sheets below $^{1}/_{8}$ inch. The same specimen, if straightened, can again be subjected to heat at the same condition stated above, and reformed. This can be repeated several consecutive times without creating surface crazing of the resin or rupture of the fabric. Thereafter, the results are erratic and unpredictable. A state of deterioration appears to set in, and the material no longer responds to conventional treatment. Fast-curing resins of the pure phenol or cresol type are usually limited to four or five reforming operations, whereas cresylic acid mixtures tend to reform many more times. In some cases wherein the proportion of phenol is obviously low, cresylic laminates are definitely heat reactive. Although capable of resisting solvents, this material behaves somewhat like the long-chain type of plastics. In view of the after-forming effect, highly plasticized resins ordinarily are not preferred to the unmodified laminating varnishes. Such material usually swells appreciably when heated and frequently produces a rough, resin-starved surface. Aniline formaldehyde or a combination aniline and phenol-formaldehyde resin possesses good formability characteristics and would have greater possibilities for serviceable uses providing dimensional stability could be maintained under severe climatic changes.

The formability characteristics of pre-cured low-pressure and contact-type resin-impregnated fabrics are comparable in many respects to high-pressure laminates. Experimentation with low-pressure laminates has been limited to several types only. Those investigated, including the allyl alcohol group, hold considerable promise.

## Deforming characteristics of fabrics

If deflected beyond their modulus of rupture in bending, thermosetting laminates will fail suddenly and completely. But before this occurs, the resin has crazed quite noticeably due to poor elongation, and cracks open up in the resin pockets between the filler and warp threads. However, when processed for forming, laminates have a different set of characteristics. The resin is no longer brittle, but soft and pliable. Accordingly, the fabric may be stretched and shaped as desired within, of course, the limiting elongation of the yarn. When, subsequently, the resin has reverted to its original condition, a forming operation has been accomplished without crazing of the resin or rupture of the fabric.

The resin binder is an amorphous compound possessing stable mechanical properties. However, with the addition of

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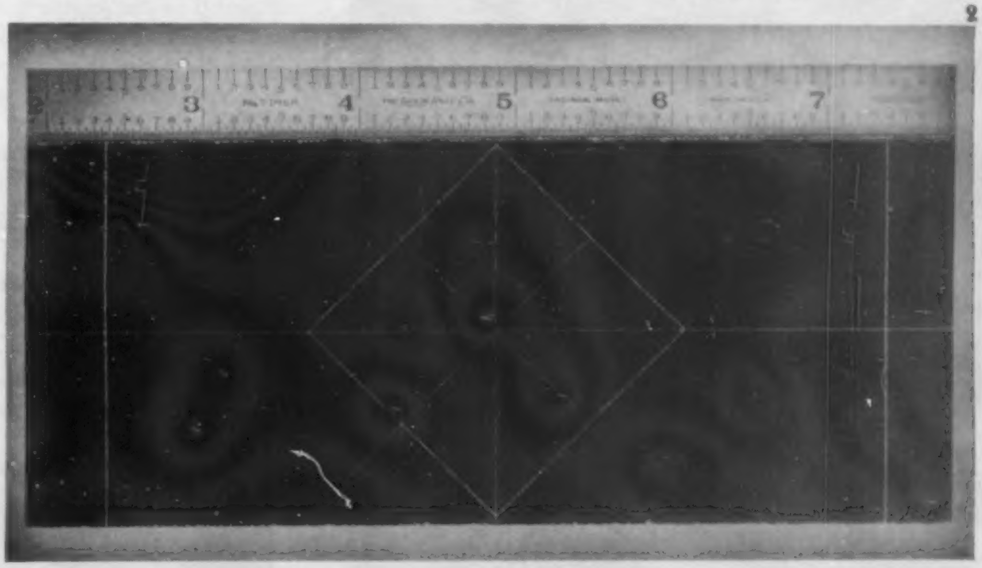
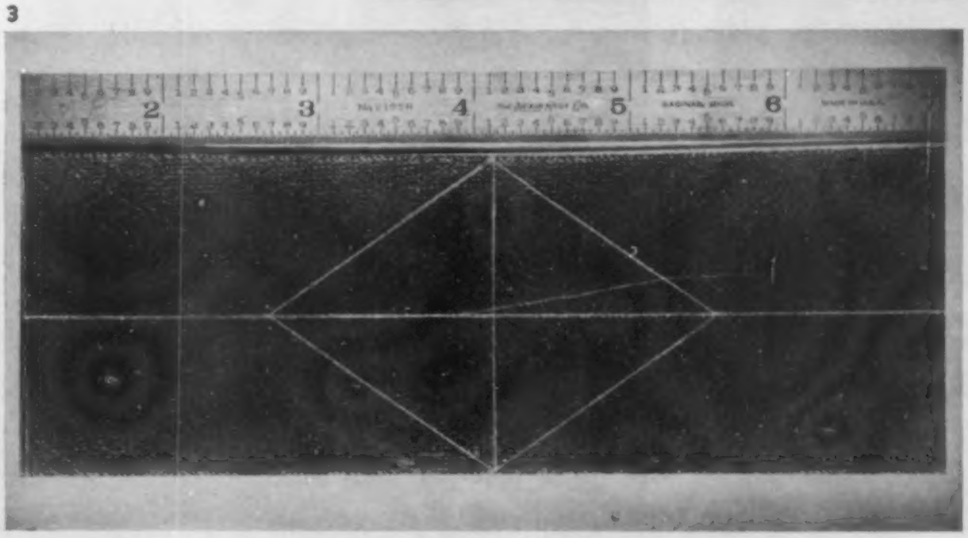


*2—Material stretched on the bias elongates more than twice as much as when pulled in either the crosswise or lengthwise direction. This stretch specimen (0 percent elongation) has been marked for a study of deformation*

3



*3—After being subjected to stretching, the specimen in Fig. 2 shows a 20 percent elongation. The application of tension loads causes the square weave pattern formed by the diagonal threads to collapse into diamond configurations. Following application of the tensile load, the diagonal threads tend to move closer together*

a filler, a wide variety of properties may be made available. These are primarily dependent upon the type of reinforcing material selected for the laminating. Of numerous types of fabric, the ones most commonly used are army ducks, twills and herring weaves, and single- or double-filled ducks. Laminates assembled from any of these fillers ordinarily have excellent forming properties. Inasmuch as technical information concerning the structure and weaving of cloth is not too readily available, the investigation was based upon a study of the stretched and unstretched surface of formed laminates. In general, the fabric filler consists of lengthwise and crosswise threads woven in several different patterns. A typical 8-oz. duck of balanced weave construction shows each thread passing under one and over one. Presumably, the filler thread shuttles in and out of the alternate warp thread and is pressed back tightly against the preceding or adjacent filler thread. Since both threads are held taut in the frame and impressed one upon the other, each has a crimped or wavy appearance. When impregnated, the resin fills the space between alternate threads and surrounds junction of filler and warp threads.

4

Although the fabric reinforcement was intended to add toughness and certain other characteristics to the resin, the mechanical properties would have been considerably greater were the threads straight instead of crimped. To a certain degree the forming of laminates accomplishes this—ultimately improving many of the physical properties.

The stretching of the threads within practical limitations is dependent upon the redistribution of the resin. When laminates are stretched, the threads parallel to the direction of the force straighten and move closer together. This movement is followed by a corresponding shortening of the threads lying normal to the direction of the force. As the respective threads move closer together, the resin occupying the space between them is squeezed out and redistributed. Attention is directed to Fig. 1 which serves to illustrate the change in thread pattern. The difference between the stretched and unstretched samples is apparent from an inspection of both the surface and an edgewise view. The threads are well defined and spaced with resin pockets as seen in the unstretched specimen. Upon stretching, the lengthwise threads tend to straighten while the crosswise threads shorten. This is visible in the pattern characteristics of the specimen elongated to 4 and 8 percent, respectively.

A marked change in the shape of the threads is to be seen in the edgewise views. The nodes of the threads lying parallel to the direction of stretch become flatter as the specimen is lengthened. On the other hand, the nodes of the opposite threads become sharper with each increment of stretch. This accounts for the prominence of the crosswise and the recession of the lengthwise threads in the surface view (Fig. 1). Accordingly, the resin which formerly occupied the spaces between adjacent threads becomes redistributed.

*4—The hand-operating dies on the rotating table in the foreground are typical of the multiple-acting dies that can be used to shape heat-formable laminates. The pneumatic presses in the background are used for heavier materials and more complicated dies. 5—A section of an ammunition chute assembly is formed in this one-stage press die. Completed parts lie to the left of the die. 6—This automatic two-stage die forms the flanged and beaded dome light bracket that can be seen at right foreground*

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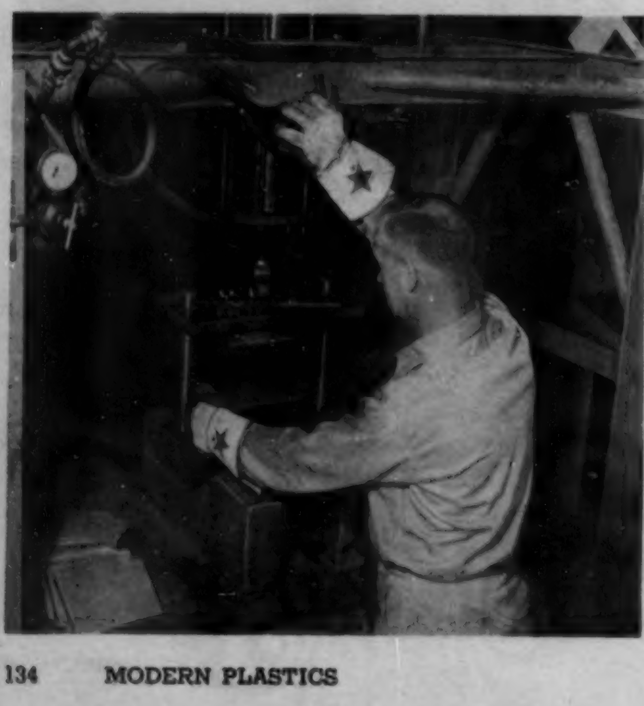

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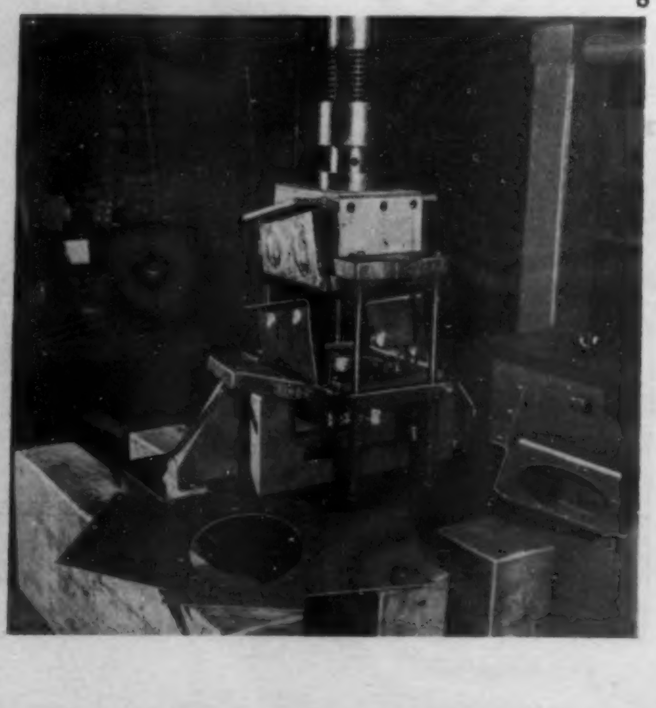

Material stretched on the bias elongates more than twice as much as when pulled in either the crosswise or lengthwise direction. Specimens extended in the bias direction behave differently from those stretched parallel to the lengthwise or crosswise threads. Whereas, in the latter cases, elongation is achieved by lengthening the threads, when the specimens are stretched on the bias, the same results are obtained by a progressive deformation of the weave. The alignment of the threads, 45° to the direction of the deforming force, adds considerably more elasticity to the cloth. Upon applying tension loads, the square weave pattern formed by the diagonal threads collapses into diamond configurations. Following the tensile load, lateral compression forces exert component pressures normal to the diagonal thread and, hence, move them closer together. Figures 2 and 3 show the bias specimen of the material subject to 0 percent and 20 percent elongation, respectively.

## Production tooling

Heat-formable laminates lend themselves admirably to low-pressure shaping methods. Because of the necessity to form or draw thermosetting materials in one continuous operation, special dies and tools were devised for this process. Furthermore, in view of the fact that when properly treated the plasticity of these materials offers little resistance to deforming forces, multiple-acting dies were designed wherein die elements operate freely in any desired plane—an asset to low-cost production. The advantages of this arrangement are fully evident in the type and arrangement of hand-operated and semi-automatic press dies illustrated in Fig. 4. In the foreground a rotating table can be seen upon which rest several hand-operating dies. These dies can be constructed of such inexpensive material as wood, masonite, Kirksite and, occasionally, laminated paper- or fabric-base plastic stock. Note should be made of the fact that no other pressure is applied to these dies except the closing pressures that are obtained by means of toggle clamps arranged in various positions. In operation, the operator rotates the table and alternately forms and removes parts as each die reaches the loading position in front of the oven. Current bench dies not in use are stored in stalls beneath the revolving table. Three pneumatic presses used for heavier materials and more complicated multiple-acting dies are shown in the background of Fig. 4. Press dies are used advantageously for shapes requiring more positive pressure to impress beads, closed or open flanges, and for drawn objects having simple or compound curvatures.

Figure 5 illustrates a one-stage press die on which a section of an ammunition chute assembly is formed. The completed parts to the left of the die represent relatively simple formed pieces having straight and curved flanges and a diagonal bead. An automatic two-stage (*Please turn to page 206*)

*7—The operation of this three-stage semi-automatic die is much the same as that of the two-stage die. The difference lies in the fact that the lateral compression members are closed by the operator and then compressed by the plunger. 8—Large parts such as this $7^1/_2$ ft. long ammunition guide chute require special presses and dies. The die for this part (shown in the background) is two-stage operation. 9—Conventional tools such as this drill jig assembly suffice for the finishing work*

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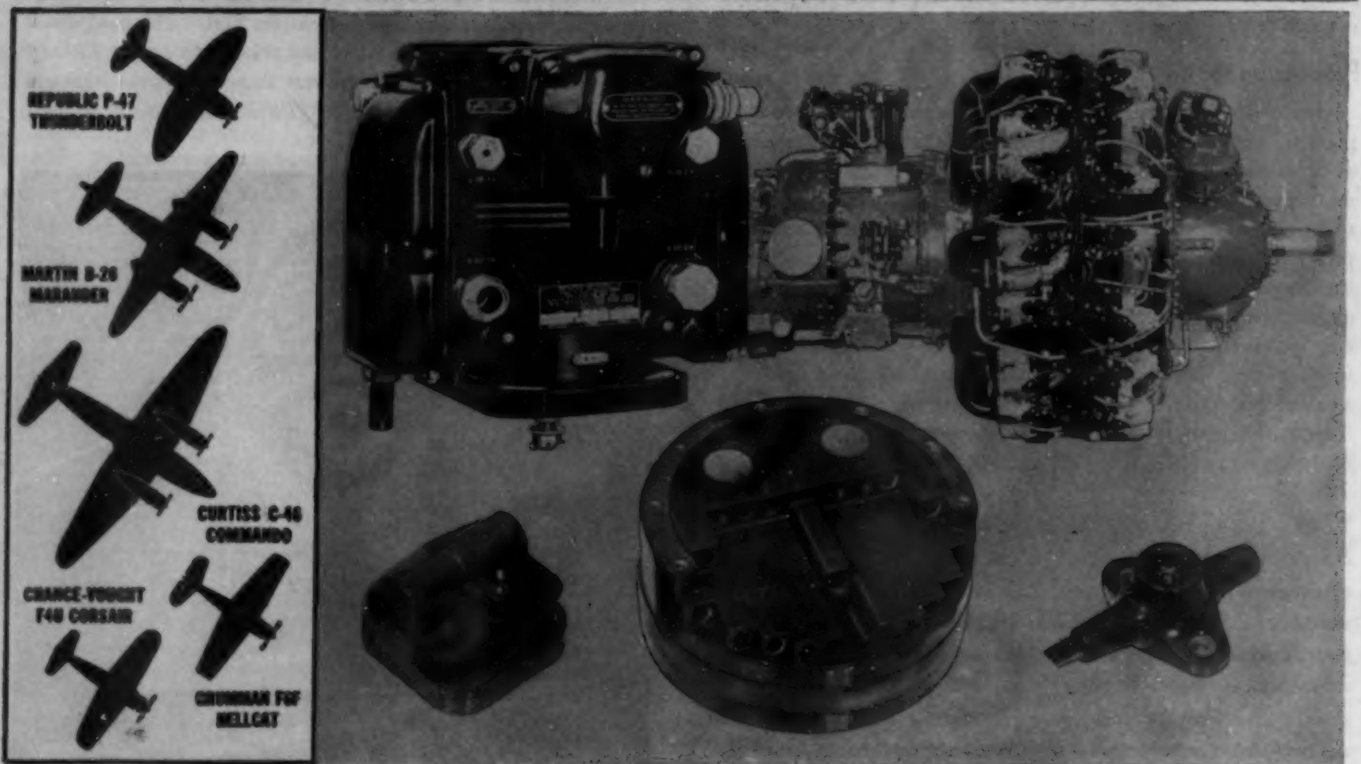
# Life ON THE PLASTICS NEWSFRONT




*(Above)* **MELMAC CONDENSER, DISTRIBUTOR HEAD AND FINGER** for the Bendix-Scintilla Aircraft Magneto DF18RN for these Pratt & Whitney R-2800 Double Wasp aircraft engines.

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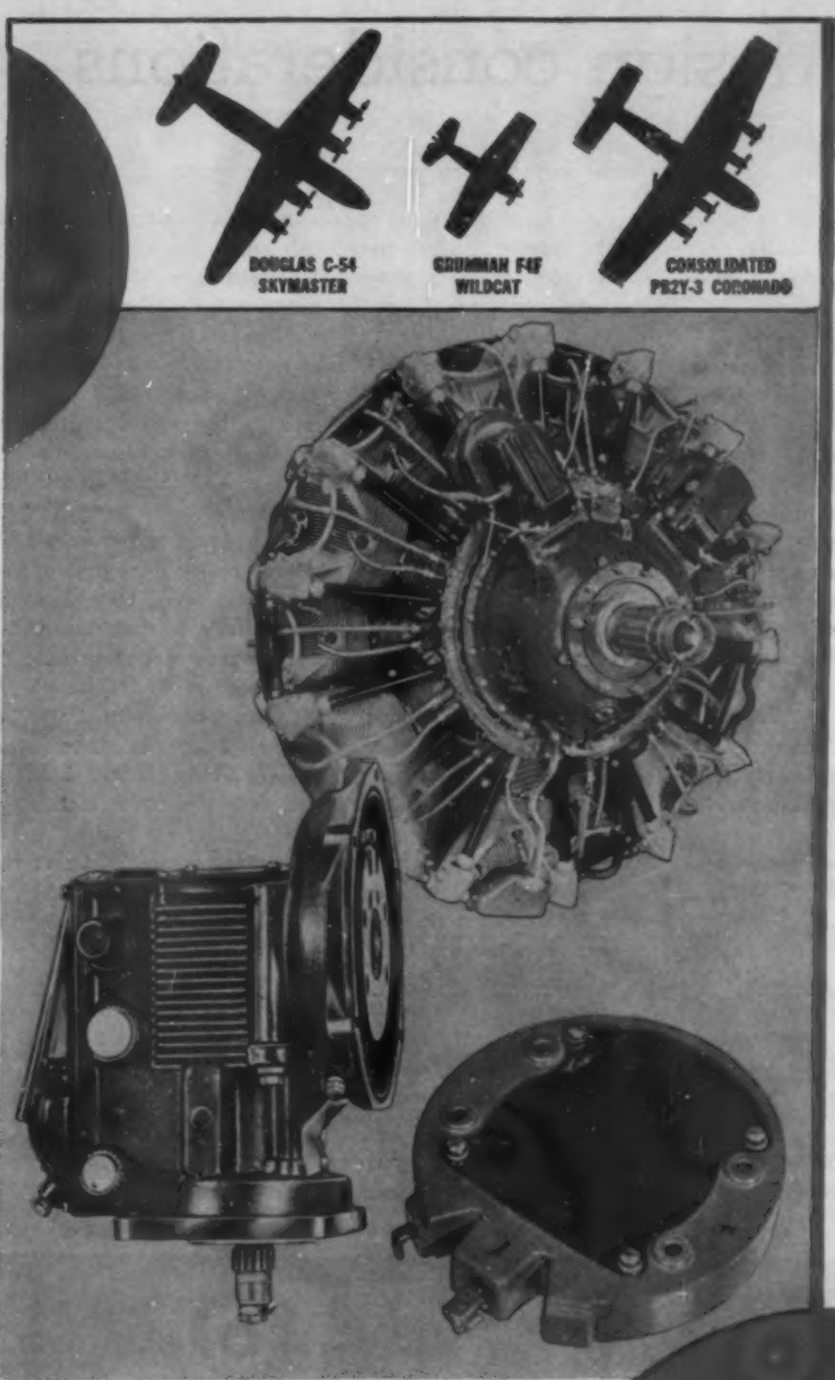
*(Below)* **MELMAC DISTRIBUTOR HEAD AND FINGER** with the Bendix-Scintilla Aircraft Magneto DFLN-5 used in the liquid cooled aircraft engines for these four Army planes.




(*Above*) **MELMAC FINGER** used on the SF14RN-8 Bendix-Scintilla Aircraft Magneto for the Pratt & Whitney R-2000 and R-1830 aircraft engines for a carrier-based fighter, a patrol bomber, and a troopship.

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# Transfer mold design considerations

by J. H. DUBOIS*

*The previous article of this series, which appeared in the October issue, indicated the four general types of transfer molds and the considerations that might lead to the selection of the desirable mold type for any given application.*

WITH the exception of the loose-plate type of transfer mold, many transfer mold cavity and plunger designs are similar to simple flash-type molds or make use of a half cavity for each section, forming a parting line in the center.

A conversion, unit was constructed as shown in Fig. 1 for the purpose of changing over a conventional compression press to a transfer press. This design contemplates the use of the "pressure" type of transfer mold using auxiliary cylinders to effect the transfer. Shown in Fig. 1 is a tandem mold installation having two complete molds, one above the other. The transfer chamber is located in the opposite side of each mold with half of the chamber in the cavity and half in the plunger. The gate is along the parting line.

The transfer rams are air operated by an airmotor[1] that permits control of the transfer ram pressure over a wide range. When single molds are used, the extra pressure cylinder may be used effectively for the operation of side cores or split molds. This novel conversion system, when used with high-frequency preheating, produces heavy parts very efficiently on a fast operating cycle.

Transfer molds that are to be used with high frequency or other improved types of preheating offer no problem in the design of the transfer chamber. Such molds are usually of the pressure type, and the area of the transfer chamber is decided upon by the size of pressure rams that are available and the volume required to hold the molding compound. Transfer pressures vary somewhat depending on the type of material used and the available preheat. Preforms that have been heated by means of high frequency will flow very fast after pressure is applied. Closing time as low as 4 sec. for the transfer of a 2-lb. charge has been achieved.

When no preheat is used or when the preforms are merely warmed on a steam plate or with infrared radiation, a large transfer chamber area may be necessary to provide adequate surface area for the application of heat to the compound. It is very important to fully heat-plasticize the material so that the transfer will take place in a reasonable length of time. When no preheat is used, the total closing time should be from 30 to 90 sec., and a large portion of that time will be used in heat-plasticizing the compound. For most materials, the square inches of heating area per ounce of material vary between 5 and 10, depending on the total weight of the load. The small factor is used for large chambers since the material, in such cases, is caused to flow over a larger heating area.

Another consideration in the design of molds of this type stems from the use of the same pressure for transfer and for clamping pressure. Unless the chamber area is larger than the combined land area, including all runners and gates, the mold may open up during the "transfer" period. Many mold designers lay out the transfer chamber area as 25 percent greater than the land area to be sure of adequate clamping pressure. To insure transfer in a reasonable length of time, the heating area calculations as outlined above must also be checked. In most cases it will be found that this area is greater than the area required for adequate clamping. How-

* Executive engineer, Shaw Insulator Co.
[1] Conversion unit and Airmotor, Rodgers Hydraulic, Inc.

***1**—This conversion unit was constructed for the purpose of changing a conventional compression press to a transfer press. **2**—The gate in this tandem pressure-type transfer mold is along the parting line*

PHOTO, COURTESY RODGERS HYDRAULIC, INC. AND PLASTICS, INC.

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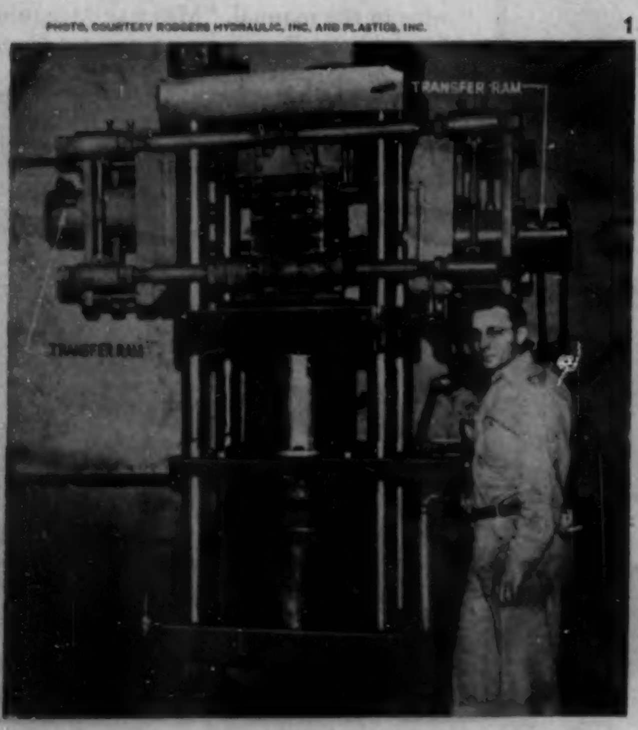


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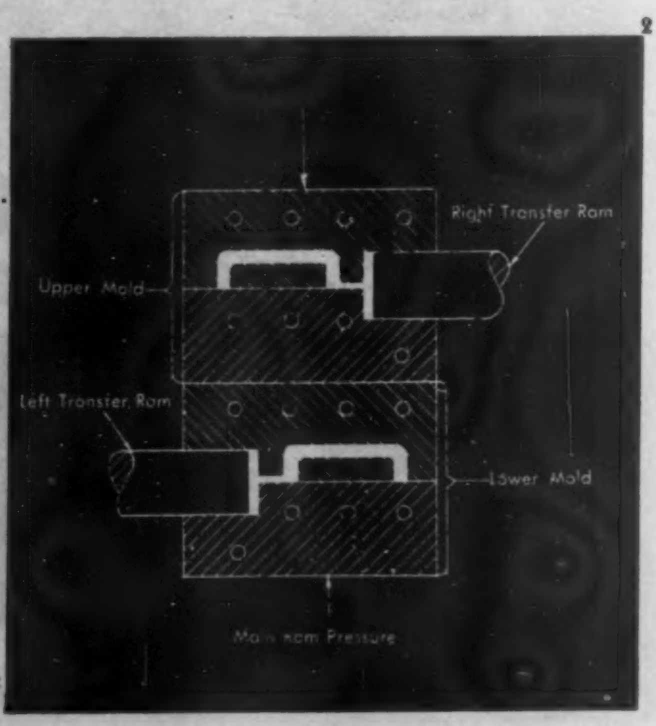

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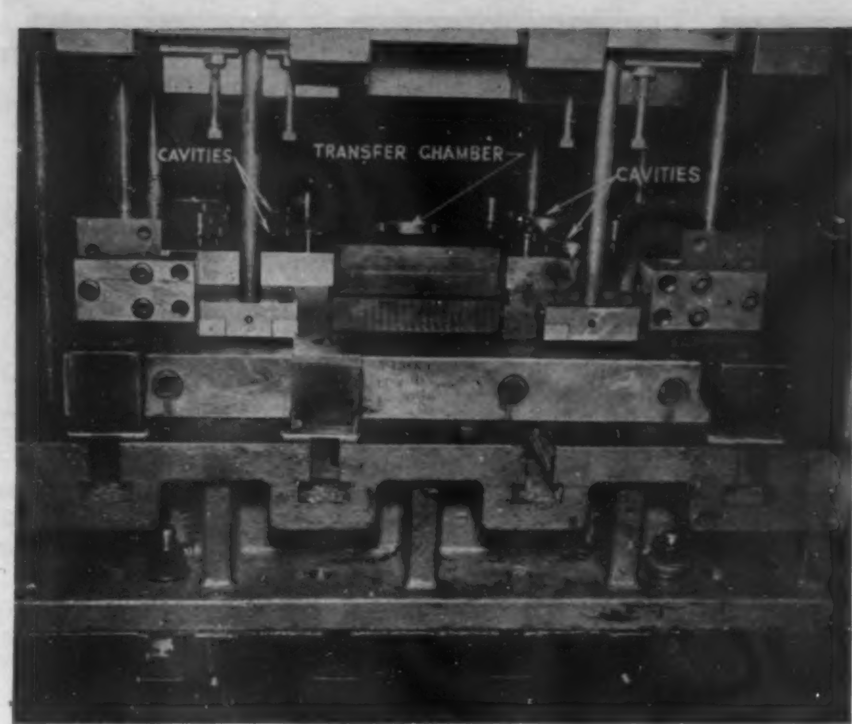


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PHOTO, COURTESY MINNEAPOLIS - HONEYWELL REGULATOR CO.
PHOTOS 5 AND 6, COURTESY SHAW INSULATOR CO.

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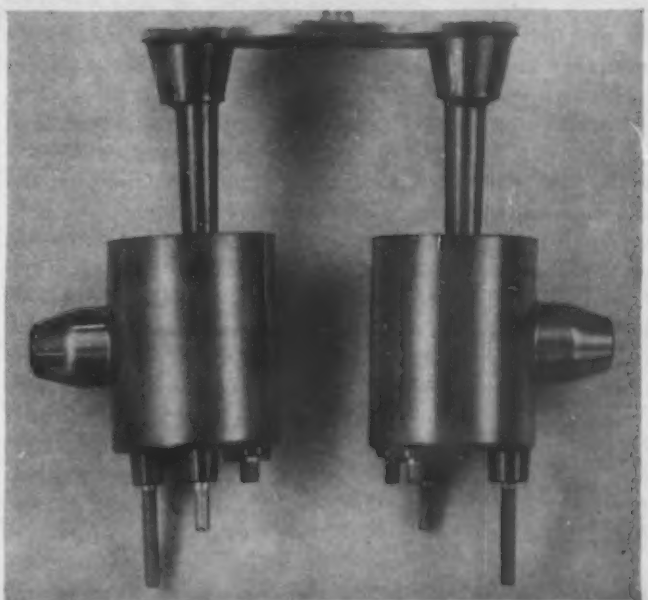

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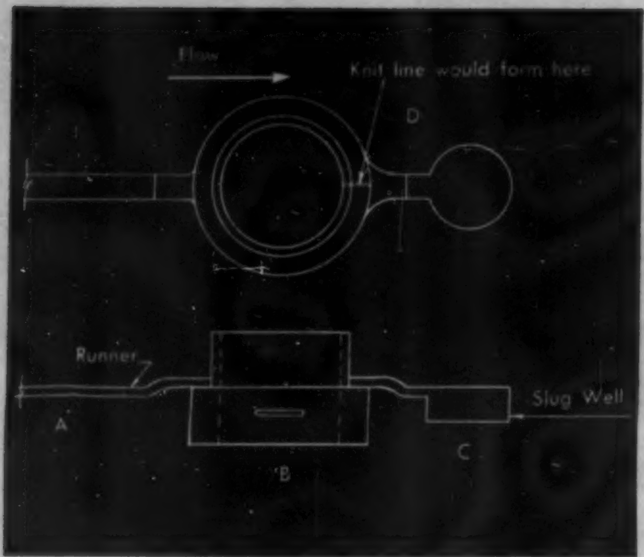
ever, the largest area indicated by these separate calculations should be selected.

Whenever possible, the transfer chamber should be placed in the center of the mold to equalize the stresses. Sprues should be placed on the center line if at all possible and, where more than one sprue is used, they should be located symmetrically with respect to the center line. When one sprue is located nearer to one end than to the other, the nearer end will close more quickly—placing a strain on the guide pins and the side wall of the transfer chamber.

While several chambers may be used in a single transfer mold, loading considerations indicate that the use of only one chamber is preferable. One of the real gains resulting from transfer molding, especially with the fabric-filled materials, comes from the elimination of the necessity for accurately weighed loads. However, when multiple transfer chambers are used in a single mold, the load for each chamber must be weighed accurately to insure adequate and uniform density in all parts. Molds with 6 to 8 transfer chambers have been operated satisfactorily but, as a general rule, multiple transfer chambers should be avoided.

Many types of sprue pullers are used to withdraw the cull and sprue from the chamber. Dovetail slots milled across the transfer plunger are very common. In many cases, it will be satisfactory to start the slot over the sprue and continue it to the back edge. A tapered wedge section directly over the sprue may be used with large area pots if the taper will permit removal of the cull by a blow on the edge. Many molders use a shallow hole in the chamber plunger which has an under-

*3—A universal pressure-type transfer mold with transfer ram operating from below. Various cavities may be installed on each side of transfer chamber. 4—These molded parts were produced in the transfer mold shown in Fig. 3. The casting is approximately 16 in. in length. 5—The gates on these molded parts are removed by drilling out the central holes. 6—This is the same piece as that shown in Fig. 5, after the gate has been removed*

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PHOTO, COURTESY GENERAL ELECTRIC CO.

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*7—So that the gate will not be located where the flow of material entering the mold is divided by pins, inserts or mold sections, this mold is so designed that the plastic enters at A, fills out part B and flows on so that the initial compound fills slug well C. This method obviates a knit line at D. 8—These transfer molded pieces show the construction of typical runners and gates for small parts. Noteworthy is the very thin resin fin on the insert*

cut ring that serves to hold the cull until it is pushed off by means of a knockout extending through this hole in the transfer plunger.

Transfer molds of the pressure type need no sprue puller since the cull, runners and gates stay in the cavity attached to the part. The entire unit is raised out of the cavity by well-located knockout pins.

Shown in Fig. 3 is a pressure-type transfer mold; the molded pieces are shown in Fig. 4. This press has an overhead ram so that the auxiliary cylinder may be mounted below the lower press platen. In this setup a universal transfer chamber is used, with cavities mounted on each side of the chamber. The preheated pills are dropped in the transfer chamber. The mold is closed in the conventional manner by the main press ram. Transfer is effected by the transfer ram. This unit is a newly designed air pressure operated ram supplied with pressure through high-pressure rubber tubing from the airmotor.

It is important in all transfer mold designs to use the minimum length of runner in order to avoid precure and to obtain minimum flow resistance. The area of the small end of the sprue should be as large as the combined areas of all gates fed by that sprue. A generous taper on the sides of runners will facilitate their release.

Ribs on the part serve as runners to feed the thin molded sections. These ribs are very helpful and, in some difficult cases, they may need to be added. Runners must not include sudden changes in the direction of flow—generous radii should be used at all turns. A generous concave section is placed at the end of sprues where the runners branch off at right angles to the cavities.

Gates used with long-fiber materials may require special consideration since the "break" may go into the part, necessitating its rejection. In cases of this nature, common practice is to add a heavy section where the gate is attached to the part. This heavy gate extension may be removed during the finishing operations. An easily removed gate is provided by gating into the location for a hole as shown in Fig. 5. A drill run through this hole in the finishing operation removes the gate stub with no apparent finish defect (Fig. 6).

The gate must not be located where the entering flow of compound may be divided by pins, inserts or mold sections. Divided flow must be avoided if at all possible. When this cannot be done, it may be necessary in order to insure a good knit line being formed, to carry the compound past the point at which the knit might normally form, out of the cavity into a "slug" well. This passage of the initial inflowing material beyond the normal knit point (Fig. 7) may serve to produce a strong section that might otherwise be weak. Knit lines are weak electrically as well as mechanically and must be avoided in quality parts. This is especially true in melamine-formaldehyde parts. Good results are often obtained by entering the gate at an angle. This initiates a "swirling" action that will help to flow the material around inserts and pins.

Gates must not be too small since oversmall gates may introduce a loss of impact strength. It is desirable to gate into or near heavy sections. Typical gates and runners for small parts are shown in Fig. 8.

The swirling action obtainable by transfer molding will vent some deep sections that could not be filled out properly by conventional molding methods. Most transfer molds require some venting to release entrapped air. Vents 0.002 in. deep will not permit any material to flow and may not give adequate venting. However, a vent 0.003 to 0.005 in. deep and $^1/_8$ to $^1/_4$ in. wide will pass a little resin and generally give a satisfactory vent. Points farthest from the gate often require venting as do all points where a knit line may be formed. The last part of the cavity to fill often requires venting. Vents are conveniently located at insert locations by means of holes through the insert-holding pin. When blind inserts are used, the insert seals the hole from the compound but allows the escape of gas. Mold pins are often provided with a flat or side slot to serve as a vent. Since vents may fill up with compound and require frequent cleaning or blowing out, they must be located where they may be watched and are easily accessible for cleaning.

An excellent guide for the location of vents makes use of a series of molded pieces showing the progressive stages in the formation of the part. This progression is produced by starting with a group of small "pills" (*Please turn to page 206*)

# The extrusion of saran

**This detailed discussion of extruded saran is the first of a series of "know how" articles dealing with the extrusion of various types of materials**

by J. A. PALMER*

SARAN is exceptionally well suited for fabrication into many forms by the extrusion process. It may be produced in either fully oriented, controlled oriented or unoriented[1] forms, depending upon its ultimate use.

Fully oriented monofilament may develop tensile strength in excess of 40,000 p.s.i., coupling this high strength with good flex life, high abrasion resistance and low temperature flexibility. Controlled orientation, which may be utilized to obtain products having properties varying between the fully oriented and unoriented material, is typified by rattan sections such as have been used for transportation and theater seating. Of particular interest in the unoriented products are pipe and tubing for conveying corrosive fluids. The low water absorption of saran in this form particularly recommends it for many difficult applications. For example, extruded tape has been widely used in the plating industry for equipment construction and part masking. Tensile strengths of the unoriented saran are of the order of 4000 p.s.i. and are coupled with high compression and flexural strength.

At the proper extrusion temperature, saran emerges from the extrusion die as a viscous liquid. The melted saran is not self-supporting and, for this reason, practical limitations are imposed on the complexity of the extruded shapes. The supporting of re-entrant angles or curved surfaces, and maintenance of sharp corners in the extruded product becomes a major problem. However, simple symmetrical forms may be readily produced in continuous lengths of desired shape.

Present commercial saran at the extrusion temperature is heat sensitive and has a definite thermal life which is a function of time with respect to temperature—conditions which make special machine design necessary if successful extrusion is to be achieved. In addition, high corrosion resistant metals must be employed throughout the working parts of the extruder. Certain metals, notably iron, copper and zinc, have a catalytic effect on the decomposition of the material at extrusion temperatures, necessitating the use of alloys of suitable chemical properties. As the softening point of saran is very close to the melting point, somewhat different operating techniques are required for extrusion. In view of these facts, the extrusion of saran will be considered from the standpoint of extruder design and operating technique.

## Machine design

Due to the heat sensitivity of saran, it is necessary to keep the volume of material in the extruder as low as is consistent with suitable operational characteristics. Thus passage of the material through the machine requires a minimum of time. So that the plastic volume will be reduced, the extruder is much shorter than those normally used in plastic fabrication. The volume is further reduced by the use of a shallow flighted screw and a thin plastic layer through final heating zone of the extruder. Figure 1 shows a cross section of such a unit.

An additional advantage is obtained by the use of the thin plastic sections for homogenizing the saran and reducing the distance through which the heat must be conducted. This permits more uniform heating of the plastic.

*The screw*—The special screw design has several features which particularly recommend it for saran extrusion. A single flight screw is used for higher-pressure characteristics—the uniformly decreasing flight-lead, coupled with the increasing root diameter, aiding in development of high pressure.

The screw in the 2-in. extruder has a total flight length of 15 in., and the root diameter tapers uniformly from a diameter of $1^{21}/_{32}$ in. at the discharge point to $1^{17}/_{64}$ in. at the feed hopper end. The flight lead decreases uniformly from the feed hopper section to the discharge end. The first half pitch is $2^{1}/_{32}$ in. (equivalent to a $4^{1}/_{16}$ in. lead) and is decreased to a 2-in. lead for the final turn at the discharge end. There are $5^{1}/_{2}$ flight turns in all.

The width of the screw flight land is $^{7}/_{16}$ in. for the full length of the screw—the wide flight lands proving beneficial in preventing back flow of the material and thus permitting use of the machine with greater clearances between the screw and cylinder. In addition, the heat transfer characteristics of the wide flight lands are of value in the maintenance of a more uniform temperature in the screw. The pressure side of the flight has a $^{3}/_{8}$-in. radius cut tangent to the root diameter; trailing side is cut at a 45° slope.

Suitable metals for the screw construction are Hastelloy A or B or Z-nickel, and in the preferred construction, the flight lands are built up with Stellite to increase the useful screw life by decreasing wear. For most efficient operation, the screw should be highly polished at all times.

*The cylinder*—The machine cylinder is similar in construction to that of a standard extrusion machine, although the length is much less. The feed box section is separately jacketed for circulation of a heating or cooling medium for temperature control. The heating section of the cylinder, which is also jacketed, is lined with Stellite No. 19 or other suitable corrosion-resistant metals such as Hastelloy or Z-nickel. Stellite No. 19 is preferable as it is harder and less subject to abrasive wear. Reference to Fig. 1 will indicate the relative positions of these jackets.

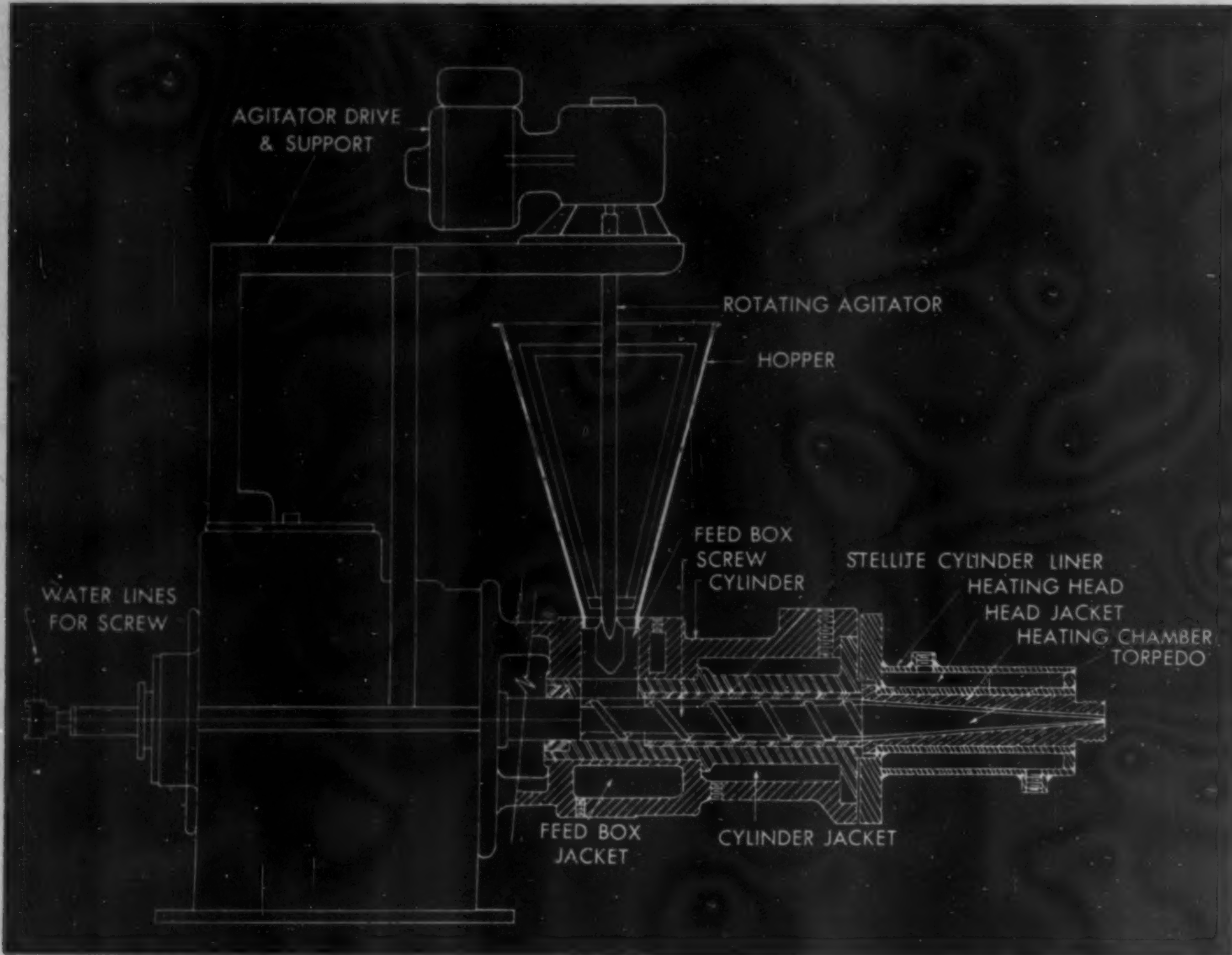
The feed box and those portions of the cylinder not Stellite bushed are plated with hard chromium which, preferably, should not be less than 0.005 in. thick. This plating prevents formation of iron rust which would contaminate the plastic.

*Operating clearance*—The clearance between the screw and cylinder walls is of the utmost importance since the plastic pressure that can be developed in the machine is dependent on this clearance. While the initial clearance is 0.005 in. on the diameter, successful extrusion at reduced output may be made after wear has increased this clearance to 0.030 inch. To a great extent, operating technique determines the success of extrusion at the greater clearance values. Obviously the extrusion rates will be lower with greater screw clearances.

*Heating head*—The saran extrusion head is a somewhat radical departure from the head customarily used in plastics

* Plastics Development Div., Dow Chemical Co.

[1] The word "unoriented" is used to describe the random orientation obtained through normal heat fabrication and subsequent crystallization.




ALL DRAWINGS COURTESY DOW CHEMICAL CO.

***1—Saran extruders are much shorter than those which are normally used in plastic fabrication. This is due to the heat-sensitivity of saran which makes it necessary to keep the volume of the material in the extruder as low as possible***

extrusion machines. The design of the present tapered head was based on the characteristics of saran and requirements for the extrusion of this plastic. The tapered form was adopted to accelerate progressively the flow of the material through the high temperature zone. Clearance in the heating head is maintained at $^3/_{32}$ in. on each side for the tapered length of the torpedo—the taper of both chamber and torpedo being $1^1/_2$ in. per foot. Figure 1 shows this design with a removable sleeve used in an all-welded heating head.

Another design for the construction of the tapered head is shown in Fig. 2. The sleeve in this case is inserted in the steam chamber with suitable packing and gaskets. It is also possible to weld the chamber in the jacket. The advantage of this type of construction is the better heat transfer from the steam jacket and the possibility of using lower operating temperatures.

A different type of heating head, which is shown in Fig. 3, employs a straight chamber and torpedo with an abruptly tapered transition section. Although the tapered head is in more general use, the straight head has been used with considerable success. Ruggedness and ease of construction are outstanding features of this head. Special metals must also be used in the heating head wherever there is contact with the saran. Hastelloy A and B are the preferred metals for these parts, although Z-nickel is suitable.

It is evident that the small clearances used in the above-mentioned types of heads will be of material aid in the mechanical working and plastification of the saran during extrusion. This thin material layer will also be far easier to heat and melt uniformly.

*Auxiliary extruder parts*—The same metals that are used with the extruder must be employed for auxiliary parts, including all elbows, crossheads, and tubing and section dies.

It is essential in the extrusion of saran that adequate agitation be permitted in the hopper and feed box. Saran is normally supplied in powder form. Since the powder is not free flowing, agitation is required to permit uniform, consistent feeding. The rotary type of agitator, indicated in Fig. 1, has proved most satisfactory for the 2-in. extrusion unit, and its operation and maintenance have been very successful. While not completely satisfactory for the 2-in. unit, vibrator feeders have been used successfully with large-sized machines.

## Heating

Electrical heating has not been satisfactory since the tendency toward overheating the saran plastic through the frictional heat that is generated has caused failure in this type of installation. Also, the difficulty of cooling the machine at shutdown has been a serious drawback. Oil heating with modified units has proved quite satisfactory—temperature

control being accomplished with relative ease. The most serious fault to be found with this type of heating has been the lag in effecting temperature changes throughout the unit. Increasing the temperatures has presented no problem, but temperature reduction has been extremely slow.

Steam has been the most satisfactory means for heating saran extrusion equipment. Moderate pressures (175 p.s.i. maximum) are required, and very rapid heating and cooling may be readily accomplished. Since the heat of vaporization is utilized in a steam system, the advantage in speed of heating may be readily seen. One pound of steam is equivalent in heating capacity to approximately 90 lb. of oil, assuming a favorable temperature drop of 20° F. in the oil. The pressure requirements have been the greatest disadvantage of the steam heating system. Small unit boilers have been used in some installations but this is not completely satisfactory since, in some cases, a licensed engineer is required for operation of the steam equipment. A choice of heating medium must be determined after consideration of all factors.

Thorough streamlining of all plastic flow paths throughout the unit is carefully observed in all design. Strict adherence to this principle is of the utmost importance. It must be pointed out that any abrupt changes or discontinuity of flow path which might impede the saran flow through the machine elements almost invariably invite trouble due to thermal degradation of the plastic. Poor physical properties, change of color, or even complete decomposition of the material may result from such procedures.

## Machine operation

Operation of the extrusion machine itself is briefly outlined below, and is the same for both oriented and unoriented extrusion.

*The screw*—The screw is used solely as a conveying and pressure producing unit. A minimum of melting is done in the screw zone to obtain maximum pressure of the plastic and optimum extrusion rates. Water cooling of the screw is recommended for at least one flight beyond the feed box and, in some cases, more cooling is desirable. A control-led screw temperature should not reach the point where the plastic adheres to the screw flights, since such a condition will reduce the machine capacity and uniformity, and introduce, as well, a possible source of thermal degradation or decomposition.

*The feed hopper*—The hopper section of the cylinder is also water cooled to prevent adhesion of saran powder to the sides of the feed box opening. Thus better plastic feeding is obtained. Agitation in the hopper section is also essential to maintain free flowing of the powder.

*The cylinder*—The temperature employed in the heated portion of the cylinder will depend to some extent on the clearance between the screw and cylinder wall. The usual operating temperature is 275° F. with an allowable range of 225 to 290° F.—the higher temperatures being used in machines having small cylinder-screw clearances. Obviously the greater fluidity encountered at the higher temperatures will be compensated for by the shear characteristics of the material in relation to the screw clearance. As wear increases this clearance, the cylinder temperature must be reduced to maintain rate and uniformity of extrusion. The temperature in the cylinder is maintained at such a point that the plastic tends to adhere to the cylinder walls while maximum slipping exists on the screw surfaces.

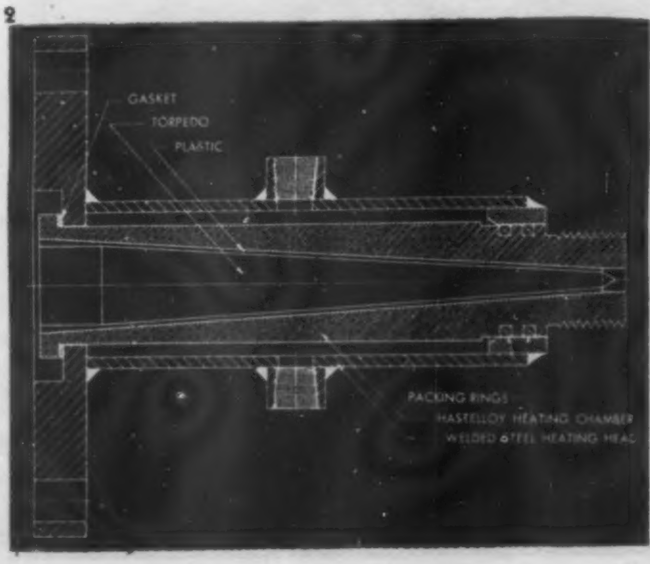
*The heating head*—Optimum temperature for the heating head or melting zone gives complete fusion of the saran without thermal degradation of the plastic. The temperature of the heating medium varies widely depending on the frictional heat developed in the machine and the style of heating head. The screw speed markedly affects this heat development and surface finish of the torpedo also is a factor in the heat generated by friction. Consequently, exact values for the head temperatures used cannot be given.

The operating temperatures of the head zone vary with individual machines and operators. They are in the range of 324 to 350° F., equivalent to 80 to 120 p.s.i. saturated steam pressure. The temperature will be governed by the style of head, condition of the machine parts, screw speed and other factors and is best determined by experience and observation. The higher temperatures may be used in starting the extrusion operation. Then, as the extrusion is established, the temperature is lowered to obtain optimum quality and rate. In operation, the heating medium in the head may act as a coolant to remove excess heat generated during extrusion.

*Auxiliary extrusion parts*—Dies, elbows and crossheads must also be heated. In these zones it is not intended to change the plastic temperature but to maintain it at a suitable temperature so that it can flow readily with minimum

***2**—The advantage of this tapered head is better heat transfer from the jacket and the possibility of using lower temperatures. **3**—In contrast, this head employs a straight chamber and torpedo with an abruptly tapered transition section*

2

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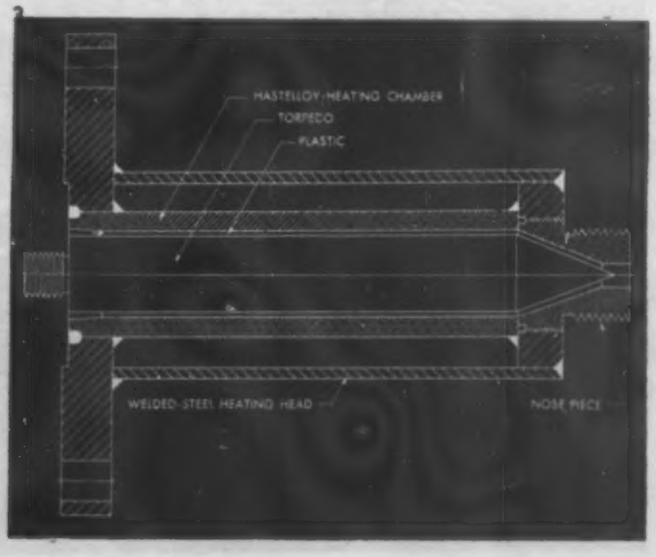


adhesion to the metal surfaces. The temperature in these parts is usually slightly higher than the temperature of the plastic as it emerges from the heating chamber.

*Starting and stopping the extruder*—With a single exception, no particular precautions are required to start an extruder for saran operation, the procedure paralleling that followed with any plastic material. One precaution, however, must be observed—too long a soaking period at the extrusion temperature must be avoided. When using steam heating equipment, the extruder normally may be started within 5 min. after the desired temperatures (and pressure) have been attained within the respective jackets. Using oil, this waiting or soaking period is approximately 35 minutes. Variation in waiting time is due to the differences in thermal capacity and conductance of the two heating mediums.

The outstanding departure from standard extrusion machine operating practice lies in shutting down the extruder at the completion of a shift or run. As previously mentioned, saran is heat sensitive and maintenance at elevated temperatures for prolonged periods of time will induce thermal degradation or decomposition. Consequently it is necessary to chill rapidly the various extrusion parts to prevent the formation of degraded material. In the case of steam heated units, this is accomplished by releasing the steam pressure and introducing water into the various jackets of the machine. The water is introduced in the lowest point of the jacket and removed from the highest point so that the various surfaces are completely surrounded by the cooling medium.

In oil heating systems, which have been designed expressly for saran, an auxiliary cold-oil reservoir is supplied. This reservoir contains a heat-exchanger coil for water so that the oil may be maintained at a suitable temperature. By means of appropriate valve arrangements, the cold oil may be circulated by the heating unit pump to achieve rapid cooling of the extruder. In single-reservoir oil systems, the same effect may be obtained through use of a heat-exchanger coil for cooling the oil. This, however, necessitates complete cooling of the oil system, and the cooling rate is somewhat lower than that obtained with the double reservoir oil unit specifically designed for saran. Cooling of an oil-heated extrusion machine by these methods is somewhat slower than water-cooling in the steam system, but it is sufficiently rapid to prevent thermal degradation of the plastic.

## Handling technique

The technique employed in the unoriented extrusion of saran is similar to that used in the extrusion of other thermoplastics. As mentioned previously saran is highly fluid as it emerges from the die and, in consequence, requires the exercise of greater care and ingenuity than is necessary with most thermoplastics to maintain the extrusion in the proper shape. As saran is normally a crystalline material, it may be reduced to an amorphous, noncrystalline state by too-rapid cooling. A less severe cooling crystallizes the saran, thus quickly hardening the material in the desired form. To achieve this result, a hot quench is employed in the production of unoriented saran. This may be a blast of heated air, a steam jet or immersion in a heated bath.

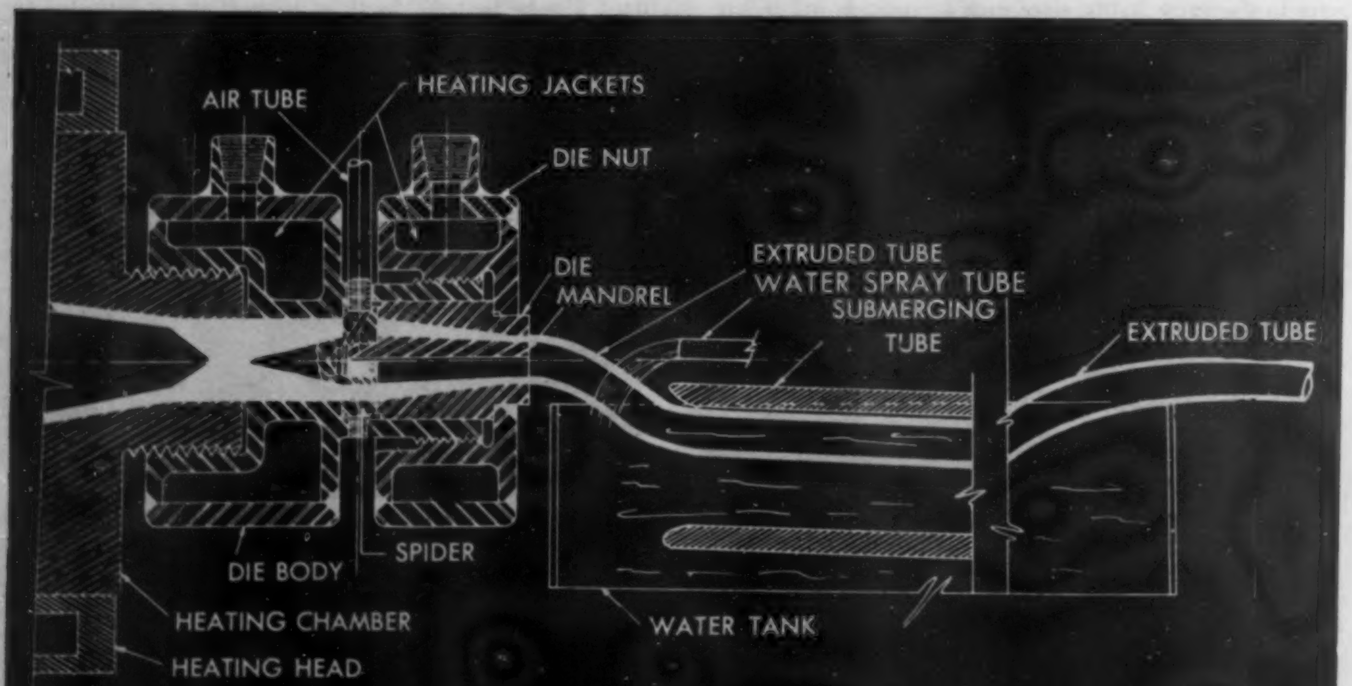
In using the heated bath, certain difficulties may be encountered when removing the crystallized, semi-rigid extruded product onto the conveyor or take-off mechanism, for distortion may occur at the die face where the material is in a fluid, readily deformable state. Proper adjustment of technique, however, will eliminate such difficulties.

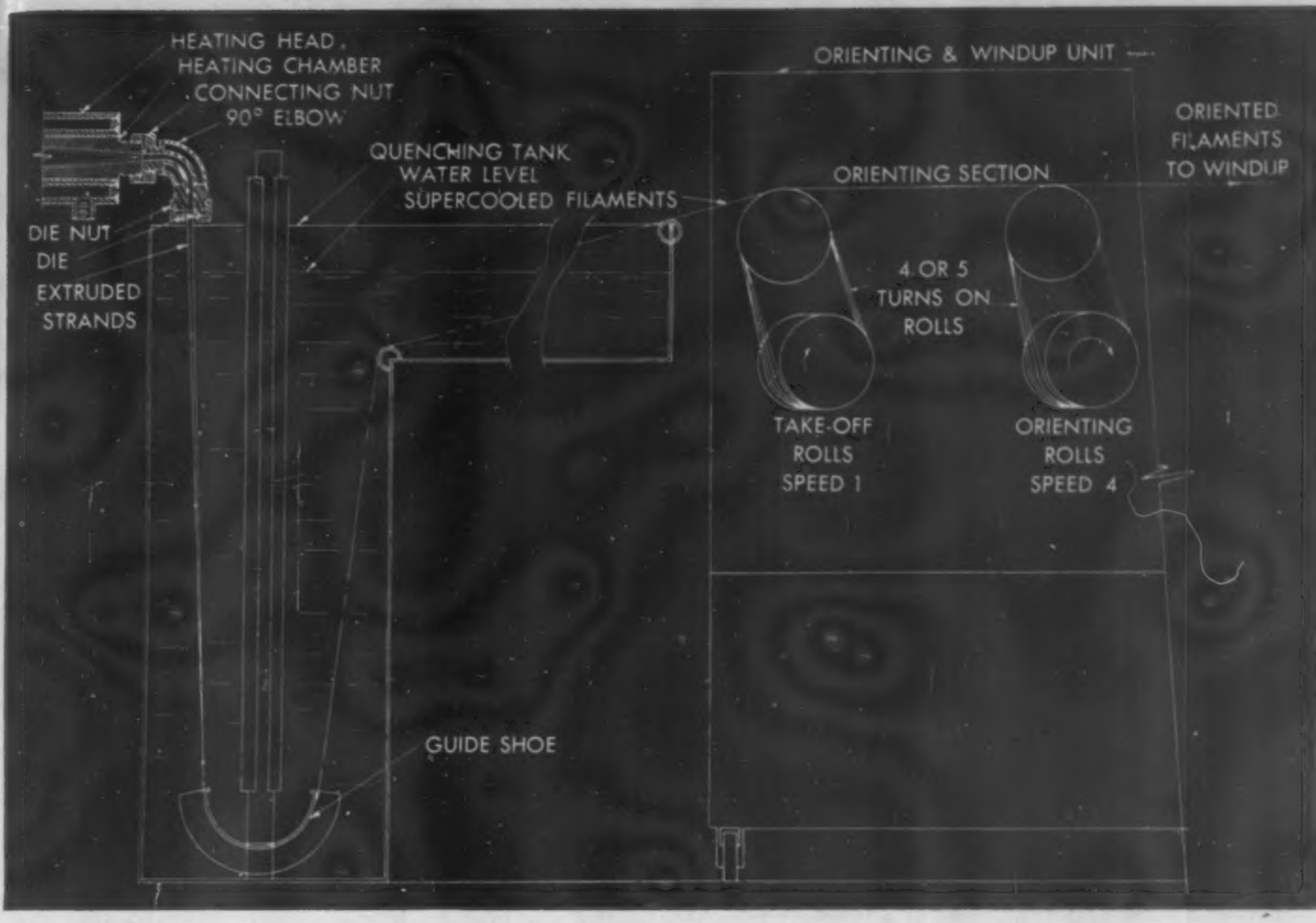
With the exception of the pipe equipment, auxiliary equipment used in unoriented saran extrusion is similar to that used for the extrusion of other thermoplastic materials. Conveyors and wind-up devices for product handling are the same.

## Unoriented extrusion

*Pipe manufacture*—Saran pipe is manufactured by a modified extrusion process in which special equipment is required.

***4—As saran tubing emerges from the extruder it is sprayed with water so that it will not adhere to the submerging tube which is used to completely immerse the plastic tube in the water tank. This bath insures uniform cooling of the tubing***






*5—This typical equipment assembly for the extrusion of oriented filaments indicates the different handling technique that is necessary in the production of oriented saran once the material has left the extrusion die*

A mandrel is passed through a crosshead die on the extruder and is coated with saran during the passage through this die. The special equipment rotates the mandrels simultaneously with their passage through the crosshead die. Both rotational and forwarding speeds are independently variable so that a wide variety of conditions may be accommodated. As a coated mandrel leaves the extrusion die, the outer surface of the pipe is quite rough and a definite spiral pattern is noticeable which reproduces the spiral motion through the die.

A smoothing operation is required to eliminate the spiral pattern and to control the pipe size. This smoothing is accomplished through two rolls, the first of which will also control the outside diameter of the pipe. The second roll will give a final smoothing to the outer surface of the pipe. The pipe is then subjected to a die-drawing operation for sizing and surface finishing after which the mandrel is removed by suitable means.

The lengths which may be produced in this process are naturally limited by the length of mandrel which may be used successfully in the process. This length is governed by the wall thickness of the pipe, the plastic temperature (i.e., rigidity) at the time of mandrel withdrawal and handling limitations of the equipment available. The shorter lengths are advisable from the standpoint of the extruder.

*Tubing*—Another phase of unoriented extrusion concerns the production of tubing. As has been pointed out, saran is very fluid at extrusion temperatures, and it is necessary to resort to very careful controls to maintain round tubing of uniform diameter. The principal difficulty encountered in accomplishing this result is the control of air pressure used in maintaining the tubing in a round form during the initial crystallization. Normally, air pressures of the order of $^1/_8$ to $2^1/_2$ in. of water are employed.

Saran tubing is extruded with the tubing end sealed so that there is no air flow through the tubing itself. The small volume of air that is required makes it extremely difficult to control the air pressure within the desired limits which, for best results, are less than $^1/_{10}$ in. water. The volume of air that is flowing should be just enough to fill the tube and maintain the desired size.

Another factor which may cause irregularity is a non-uniform extrusion rate. Non-uniform speed of the take-off device such as the conveyor belt is a very common cause of size variation.

A typical assembly for the extrusion of tubing is shown in Fig. 4, where the thorough streamlining employed in the die construction may be readily observed. Air for inflation of the tubing is introduced through the mandrel. As the extruded tubing tends to float on the water bath, a submerging tube is employed to immerse the extruded plastic tube completely so that cooling will be uniform. A water-spray tube is used as indicated to quench and lubricate the extruded saran so that it will not adhere to the submerging tube.

The temperature of the water may vary over wide limits and will be dependent on the size (mass) of tube being extruded and the time of immersion in the bath. Temperatures of the order of 100° F. have been satisfactory for a wide range of sizes. Tubing is removed from the water bath by such

suitable means as take-off rolls or conveyors. Constant uniform speed is of the utmost importance.

Other unoriented shapes such as tape, edgings and similar forms are handled in the same fashion as tubing. In these cases the submerging tube and water spray will not be required since the plastic will sink of its own weight. However, the effects of surface tension may require special means to submerge the extruded shape initially.

*Wire coating*—For wire coating operations the technique is essentially the same as that used throughout the plastic wire coating industry. In order to prevent cracking of the plastic, the coated wire is initially supercooled, followed by crystallization in the conventional heated bath. As the supercooled material has a very high elongation factor, cracking will not be encountered due to shrinkage of the saran about the wire so that the material, when crystallized, will actually expand. However, supercooling may be adjusted so that an adequate grip or adherence to the wire will be obtained. Take-up and wind-up equipment may be the same as that employed throughout the wire coating industry.

## Oriented extrusion

*Fully oriented monofilaments*—The production of oriented monofilaments requires a different handling technique after the saran has left the extrusion die. One precaution which must be observed is the maintenance of a sufficiently high plastic temperature to insure complete melting of the saran. By this means the crystal structure of the polymer will be completely removed, and totally amorphous saran will be extruded. Figure 5 indicates a typical equipment assembly for production of oriented filaments.

After the material has left the die, it is immediately immersed in a water bath maintained at a temperature sufficiently low (normally about 50° F.) so that crystallization will not be started and a strand of amorphous supercooled saran is obtained. This strand is drawn away from the die through the water bath at a uniform rate by means of a set of snubbing or take-off rolls. The snubbing rolls are positively driven so that a section of uniform size may be obtained within the limitations of the extrusion machine. The strand of saran is then passed to a set of orienting rolls which are driven from the take-off rolls through a friction clutch. The free speed of the orienting rolls is approximately 660 percent of the take-off roll speed. As the material is placed on the orienting rolls, the clutch slips to such an extent that complete orientation or stretching is obtained. Reference to Fig. 5 will illustrate this process.

The force required for orientation varies with the size of the section and with the temperature of the supercooled strand. The stretching force may be varied by altering the tension on the orienting-roll friction clutch so that sections of various sizes may be accommodated. The slip in the friction clutch under normal operating conditions is such that complete orientation (approximately 400 percent stretch) is obtained. The high tensile strength of oriented saran is developed through this orientation.

Higher strengths are obtained in the smaller strands by a more thorough supercooling of the material during the quenching operation. Due to the low thermal conductivity of this plastic, the large sizes have a tendency to crystallize partially at the center of the section. As a consequence, full orientation is not possible in these larger sizes and somewhat lower unit tensile-strength values are obtained. A longer immersion in the bath permits more complete supercooling of the larger sizes with resultant higher strengths.

After orientation, the saran is taken away by suitable wind-up or reeling equipment. The design of the wind-up equipment may be varied widely to suit the manufacturer's needs for this operation.

*Rattan, controlled orientation*—Full unidirectional orientation of saran produces filaments having exceptionally high tensile strength in the direction of orientation. Unfortunately the fully oriented material exhibits rather low transverse strengths in comparison with the longitudinal strength. Although no detrimental effects from this are observable in uniform sections such as cordage, in the rattan or cane sections used in seating and upholstering, this low transverse strength may be evidenced by splitting of the section when it is sharply bent. This effect may be minimized by producing the rattan section in a controlled degree of orientation. Experimentation has established that, for this application, approximately 75 percent of full orientation (300 percent stretch) will yield the most suitable over-all properties in a finished section.

Rattan fabrication follows the same general procedure as that used in producing fully oriented monofilaments. Controlled stretch is obtained through connecting the orienting and take-off rolls in the desired ratio. This is normally accomplished through a chain drive, and the stretch is fixed at 300 percent. However, this positive drive alone will not necessarily yield the desired uniform product. Consequently it is necessary to introduce a controlled degree of crystallization in the rattan prior to stretching, achieved through quenching in a controlled temperature water bath. The temperature required in the water bath will be dependent on the size of the section and the time of its immersion. Typical water bath temperatures may vary from 104 to 122° F. The higher temperature ranges are advisable if they can be used without adversely affecting the surface finish of the oriented strand.

Water bath temperatures above 122° F. will almost invariably yield a finished rattan having a dull matte surface rather than the glossy surface usually desired. The optimum temperature of the water bath will be determined by the stretching force required to orient the rattan. Best operation has been achieved when a stretching force of 12 to 14 lb. (5700 to 7000 p.s.i.) is required for the medium-sized rattan section. Tensions greater than this tend to give slubbing in the section during orientation. Slubbing may be defined as non-uniform orientation and is evidenced as lengths of reduced section followed or preceded by lengths of enlarged unoriented saran. Change in section size will be quite abrupt, and the lengths of the slub area will be quite short.

Adjustment of temperatures and tensions within the above ranges during operation will yield partially oriented sections that have longitudinal tensile strengths of 15,000 p.s.i. and over, yet retain adequate transverse strength and resistance to splitting when sharply bent.

## Conclusion

Although the procedure for extrusion and operation given above may sound somewhat involved and complicated, no difficulties will be experienced in extruding saran so long as the principles of operation and design as outlined are followed. Actual operation within the fabricator's plant will reveal the latitude which is permitted in operating conditions. The extruder will discover many small changes and variations in the operations as outlined, which may well yield increased production rates and higher quality. As no two extrusion units perform in precisely the same manner under apparently identical operating conditions, it is to the extruder's advantage to determine optimum operating conditions for each machine.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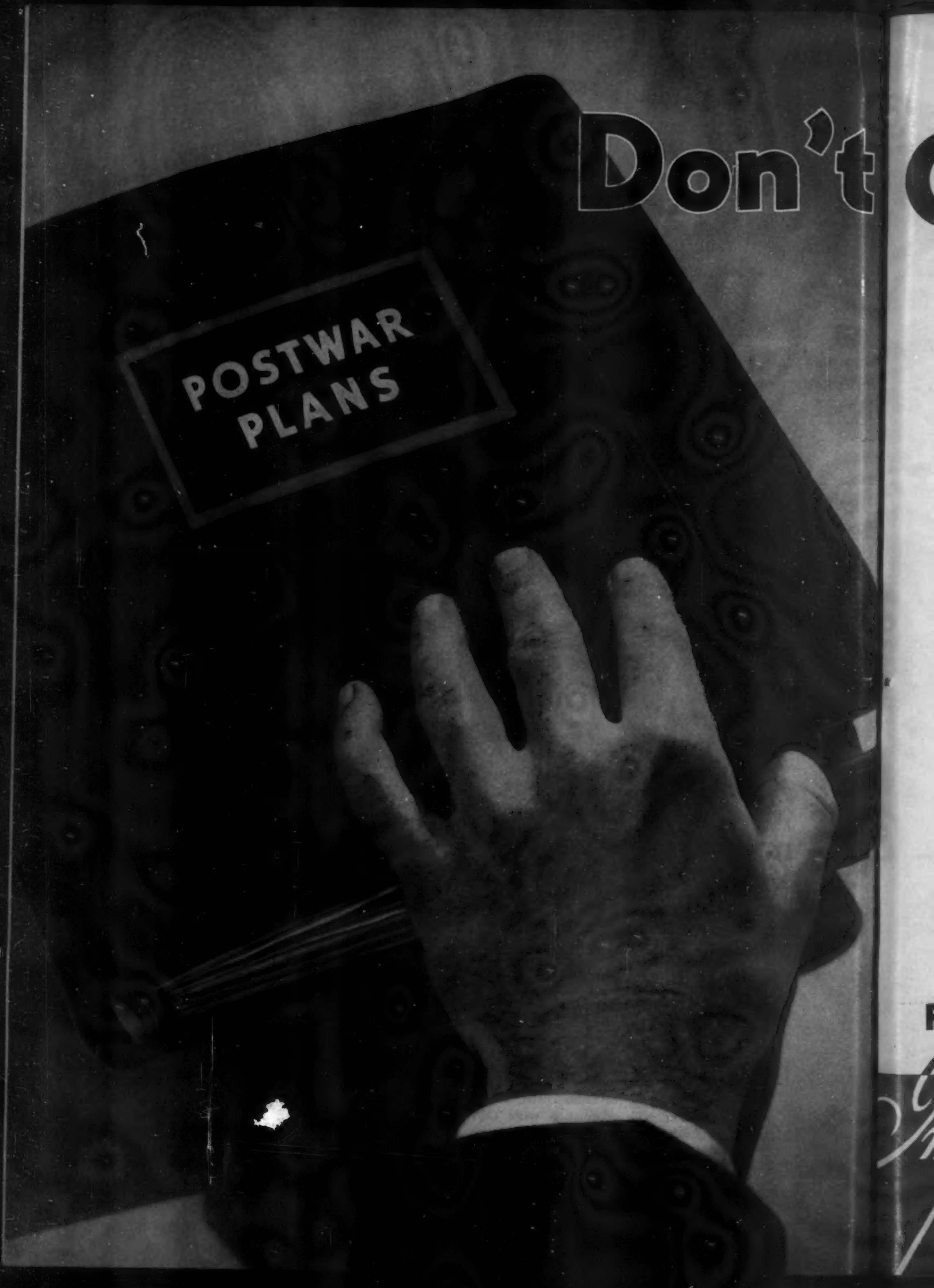
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# TECHNICAL SECTION

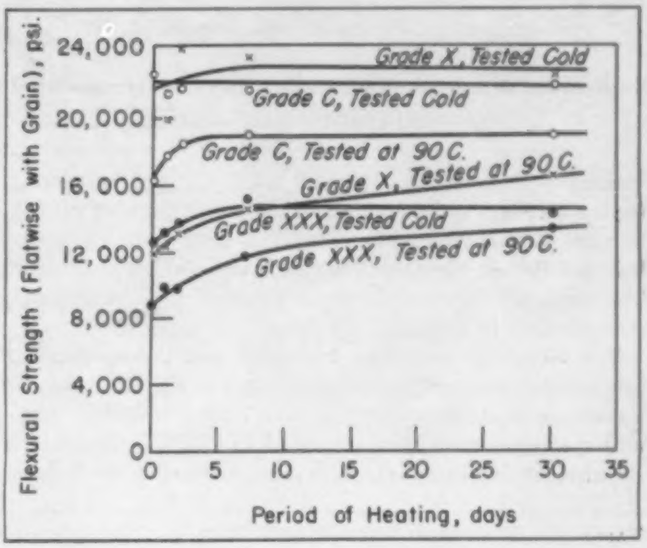
DR. GORDON M. KLINE, Technical Editor

# Heat resistance of laminated plastics[1,2]

by E. O. HAUSMANN,[3] A. E. PARKINSON[3] and G. H. MAINS[4]

EARLY in 1933 following the request of the Advisory Technical Committee of the N.E.M.A. Laminated Products Section, Subcommittee III of A.S.T.M., Committee D-9, appointed a section to study heat resistance of laminated materials. The original work covered tests on Grades X and XXX (paper base) and Grade C (cotton fabric base) phenolic laminated materials. Flexural-strength specimens, 5 × 1/2 × 1/2 in. thick, were exposed for periods up to 30 days at 90° C. by immersion in transformer oil, and tests were made both at 90° C. and at room temperature, i.e., 25° C. (All flexural-strength measurements referred to in this paper were made in accordance with A.S.T.M. Method D 229, using an 8:1 span depth ratio.) The tests at 90° C. were made by removing the specimens from the hot oil and immediately testing. It is recognized that the temperature of the specimen dropped somewhat during the period of the test, which was of the order of 3 minutes. The data obtained are shown in Table I and Fig. 1.

The data in Table I and Fig. 1 indicate that the strength of the three grades of phenolic laminate is much less at 90° C. than at 25° C. After one hour's exposure at 90° C., material tested hot shows only 50 to 70 percent of the original cold strength. Continued exposure to 90° C. for periods up to a month shows no change in strength for Grade C (tested cold) and a slight increase in strength for Grades X and XXX. In all cases, the strength measured hot increases with continued exposure to heat, the difference between the hot and cold strength becoming smaller. The results of this series of tests indicated that flatwise flexural tests measured at room temperature after various periods of exposure to heat would be most promising in indicating the changes in properties.




1—*Effect of heating on flexural strength of laminates*

### Effect of heating at various temperatures

The first work covering a range of temperatures was done with Grade XX paper-base phenolic laminate, heating for

[1] Presented at the A.S.T.M. Symposium on Plastics held in Philadelphia, Pa., on Feb. 22–23, 1944, and published here through the courtesy of the American Society for Testing Materials.

[2] This paper represents the work of Section 3 on Thermal Properties of Subcommittee III of A.S.T.M. Committee D-9 on Electrical Insulating Materials. The authors acknowledge the valuable assistance rendered by members of the technical staffs of the Continental Diamond Fibre Co., National Vulcanized Fibre Co. and Westinghouse Electric and Manufacturing Co.; also, the helpful suggestions by various members of Section 3.

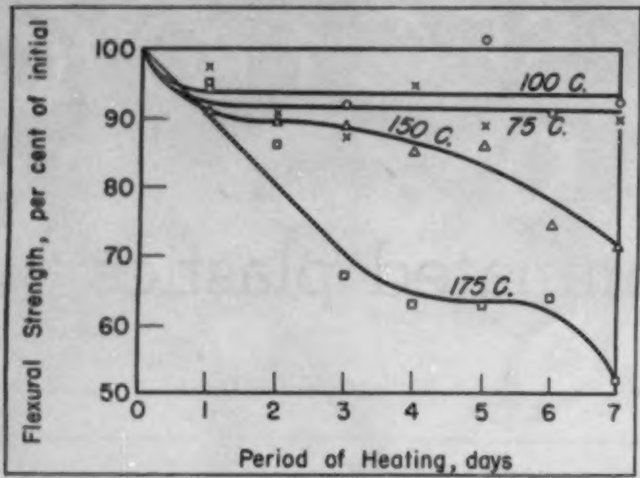
[3] Continental Diamond Fibre Co.

[4] National Vulcanized Fibre Co.

TABLE I.—EFFECT OF HEATING AT 90° C. ON FLEXURAL STRENGTH OF PHENOLIC LAMINATES

| *Treatment of specimen* | *Condition of test* | *Flexural strength for specimens tested in direction[a] shown* — *Grade C* FW | *Grade C* EW | *Grade XXX* FW LW | *Grade XXX* EW LW | *Grade XXX* FW CW | *Grade XXX* EW CW | *Grade X* FW LW | *Grade X* EW LW | *Grade X* FW CW | *Grade X* EW CW |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *p.s.i.* | *p.s.i.* | *p.s.i.* | *p.s.i.* | *p.s.i.* | *p.s.i.* | *p.s.i.* | *p.s.i.* | *p.s.i.* | *p.s.i.* |
| As received | Cold | 22,400 | 20,900 | 12,300 | 13,600 | 10,750 | 11,200 | 21,800 | 23,000 | 17,500 | 17,700 |
| 1 hr. at 90° C. | Hot | 16,100 | 16,400 | 8,600 | 9,600 | 6,700 | 8,000 | 11,750 | 12,500 | 9,400 | 9,700 |
| 24 hr. at 90° C. | Cold | 21,200 | 19,300 | 12,900 | 14,100 | 10,300 | 11,500 | 19,700 | 22,300 | 15,200 | 16,100 |
| 24 hr. at 90° C. | Hot | 17,600 | 16,400 | 9,700 | 10,500 | 7,200 | 8,900 | 12,200 | 13,800 | 10,100 | 10,100 |
| 48 hr. at 90° C. | Cold | 21,500 | 20,000 | 13,700 | 15,900 | 10,700 | 13,100 | 23,900 | 24,600 | 16,200 | 17,300 |
| 48 hr. at 90° C. | Hot | 18,400 | 16,300 | 9,600 | 12,000 | 8,400 | 9,600 | 13,000 | 14,300 | 10,900 | 11,100 |
| 1 wk. at 90° C. | Cold | 21,500 | 20,200 | 15,000 | 15,700 | 11,600 | 13,800 | 23,500 | 23,900 | 16,200 | 17,700 |
| 1 wk. at 90° C. | Hot | 18,800 | 16,500 | 11,600 | 12,700 | 8,900 | 10,700 | 14,500 | 15,700 | 11,500 | 11,800 |
| 1 mo. at 90° C. | Cold | 22,100 | 19,200 | 14,300 | 14,900 | 11,500 | 12,500 | 22,800 | 24,600 | 17,800 | 16,500 |
| 1 mo. at 90° C. | Hot | 19,100 | 17,100 | 13,400 | 13,700 | 10,300 | 10,400 | 16,700 | 16,200 | 13,400 | 12,200 |

[a] Code for directions: FW—Flatwise. EW—Edgewise. LW—Lengthwise. CW—Crosswise.




*2—Relative trends of flexural strength of specimens after exposure to various temperatures*

various periods at 75, 100 and 150° C., and measuring flexural strength and certain electrical properties after cooling to room temperature. The electrical tests included power factor, dielectric constant, loss factor and dielectric strength. The electrical data are shown in Table II and the flexural-strength data in Table III.

The electrical properties improved and the mechanical properties showed no change, except that at 150° C. there was a decrease of about 30 percent after 7 days' heating. Flexural specimens were then subjected to 175° C. Significant impairment of flexural strength was observed after 3 days, with a decrease of about 50 percent after 7 days' heating. Figure 2 shows the relative trends of flexural strength after exposure to various temperatures. While it might appear from the curves in Fig. 2 at 75 and 100° C. that there is a slight decrease in strength, these values for the period shown are well within the experimental error of the flexural-strength test. Certain intermediate values are even above the original strength. Curves for the crosswise strength values show almost identical trends and are therefore omitted.

TABLE II.—ELECTRICAL PROPERTIES[a] OF 1/16-IN. THICK GRADE XX PHENOLIC LAMINATE AFTER EXPOSURE FOR VARIOUS PERIODS AT 75, 100 and 150° C.

| *Period of exposure prior to test* | *Exposure tempera-ture* | *Short-time dielectric strength* | *Power factor at 10⁶ cycles per sec.* | *Dielectric constant at 10⁶ cycles per sec.* | *Loss factor* |
|---|---|---|---|---|---|
| *days* | ° *C.* | *v./mil* | | | |
| 0 | 75 | 887 | 0.0324 | 5.34 | 0.173 |
| 1 | 75 | 927 | 0.0294 | 4.95 | 0.145 |
| 2 | 75 | 898 | 0.0284 | 4.95 | 0.141 |
| 3 | 75 | 904 | 0.0251 | 4.87 | 0.123 |
| 4 | 75 | 932 | 0.0288 | 4.76 | 0.137 |
| 5 | 75 | 932 | 0.0272 | 4.71 | 0.128 |
| 6 | 75 | 965 | 0.0260 | 4.74 | 0.123 |
| 7 | 75 | 948 | 0.0262 | 4.65 | 0.122 |
| 0 | | 887 | 0.0324 | 5.34 | 0.173 |
| 1 | 100 | 919 | 0.0302 | 4.88 | 0.148 |
| 2 | 100 | 946 | 0.0254 | 4.64 | 0.118 |
| 3 | 100 | 943 | 0.0216 | 4.56 | 0.0989 |
| 4 | 100 | 937 | 0.0253 | 4.50 | 0.114 |
| 5 | 100 | 950 | 0.0241 | 4.45 | 0.109 |
| 6 | 100 | 955 | 0.0244 | 4.55 | 0.110 |
| 7 | 100 | 951 | 0.0227 | 4.39 | 0.100 |
| 0 | | 887 | 0.0324 | 5.34 | 0.173 |
| 1 | 150 | 936 | 0.0245 | 4.61 | 0.113 |
| 2 | 150 | 956 | 0.0237 | 4.54 | 0.107 |
| 3 | 150 | 944 | 0.0232 | 4.47 | 0.102 |
| 4 | 150 | 942 | 0.0239 | 4.54 | 0.108 |
| 5 | 150 | 961 | 0.0244 | 4.56 | 0.111 |
| 6 | 150 | 917 | 0.0241 | 4.57 | 0.111 |
| 7 | 150 | 901 | 0.0246 | 4.64 | 0.114 |

[a] Tests made at 25° C. on specimens cooled to that temperature.

## Visible deterioration at high temperatures

*Constant rate of rise*—New applications in both electrical and mechanical fields involving exposure to higher temperatures necessitated further investigation of the heat resistance of phenolic laminates. This is particularly true since a large portion of failures of insulation in electrical equipment is mechanical. Hence, a study of factors which may affect mechanical strength is important. Recognizing this need, plans were made for further study early in 1939 and the work has extended over a period of several years.

This new investigation included attempts to determine the highest temperatures to which materials could be exposed without visible changes such as blistering, delaminating, cracking, etc., which would render material useless.

The effect on the materials of a constant rate of rise of temperature to 263° C. in a period of 45 min. was investigated. The test specimens were 2 × 2 × 1/8 inch. In this work all of the standard phenolic laminates, vulcanized fibre, and some special grades and combinations were studied. The results are shown graphically in Fig. 3. The standard N.E.M.A. and A.S.T.M. grade designations are used for phenolic laminated and thermosetting laminated sheets. Vulcoid is a vulcanized fibre impregnated with a resin to improve moisture resistance and certain other characteristics. Diamond-Dilecto is vulcanized fibre coated with phenolic resin and laminated. Grade GB is woven Fiberglas-base phenolic laminated material.

The chart indicates that AA and GB inorganic fabric-base materials are definitely superior in resistance to blistering. The other grades do not indicate such marked differences,

TABLE III.—FLEXURAL STRENGTH[a] OF 1/16-IN. THICK GRADE XX PHENOLIC LAMINATE AFTER EXPOSURE FOR VARIOUS PERIODS AT 75, 100, 150 AND 175° C.

| *Period of exposure prior to test* | *Ultimate flexural strength after exposure to:* 75° C. | 100° C. | 150° C. | 175° C. |
|---|---|---|---|---|
| *days* | *Lengthwise direction, p.s.i.* | | | |
| 0 | 28,220 | 28,220 | 28,220 | 23,220 |
| 1 | 27,720 | 26,560 | 25,780 | 22,190 |
| 2 | 25,620 | 25,120 | 25,260 | 20,130 |
| 3 | 24,560 | 25,900 | 25,140 | 15,770 |
| 4 | 26,740 | 26,140 | 24,080 | 14,790 |
| 5 | 25,120 | 28,680 | 24,440 | 15,760 |
| 6 | 25,860 | 25,800 | 21,120 | 15,010 |
| 7 | 25,490 | 26,100 | 20,280 | 12,190 |
| | *Crosswise, direction p.s.i.* | | | |
| 0 | 23,920 | 23,920 | 23,920 | 18,310 |
| 1 | 22,680 | 22,960 | 23,120 | 20,840 |
| 2 | 21,200 | 19,020 | 21,660 | 18,400 |
| 3 | 21,260 | 21,340 | 23,220 | 11,920 |
| 4 | 22,340 | 22,080 | 20,540 | 13,630 |
| 5 | 20,800 | 22,340 | 20,360 | 14,020 |
| 6 | 29,920 | 20,360 | 18,240 | 13,570 |
| 7 | 19,840 | 22,000 | 15,820 | 9,630 |

[a] Tests made at 25° C. on specimens cooled to that temperature.

TABLE IV.—DIMENSIONAL CHANGES OF PHENOLIC LAMINATES HEATED AT 225° C.

| Material | Direction of measurement | Dimensional changes (percent of original) after heating for: 1 hr. | 2 hr. | 4 hr. | 7 hr. | 14 hr. |
|---|---|---|---|---|---|---|
| | | % | % | % | % | % |
| XXP | Lengthwise | −0.40 | −0.33 | −0.30 | −0.37 | −0.37 |
| | Crosswise | −0.43 | −0.43 | −0.47 | −0.56 | −0.60 |
| | Thickness | −1.2 | −0.40 | −1.2 | −2.0 | −2.8 |
| CE | Lengthwise | −0.50 | −0.67 | −0.83 | −1.0 | −1.43 |
| | Crosswise | −0.47 | −0.50 | −0.83 | −0.90 | −1.57 |
| | Thickness | +3.8 | +3.8 | +4.3 | +3.1 | +3.0 |
| LE | Lengthwise | −0.33 | −0.56 | −0.53 | −0.73 | −1.36 |
| | Crosswise | −0.53 | −0.60 | −0.76 | −1.10 | −1.93 |
| | Thickness | +6.8 | +8.5 | +6.5 | +7.3 | +5.8 |
| AA | Lengthwise | −0.37 | −0.33 | −0.33 | −0.33 | −0.43 |
| | Crosswise | −0.47 | −0.40 | −0.30 | −0.33 | −0.33 |
| | Thickness | +1.7 | +1.7 | +1.7 | +0.90 | +0.90 |

running from 220 to 260° C. The hard-paper types such as A and X are in the poorest class, and this ties in generally with lower bonding strength for these types. Also, most of the punch-plate grades fall in this same class because of the low softening point of the resin. It will be noted that the punch-plate Grade XP has higher blistering temperature than many other grades. This is possibly due to the higher boiling point plasticizers used in varnish for this type of material.

*Step-by-step heating*—A second phase of the study of blistering under heating involved increase in temperature by steps or increments of 25° C. with various periods of exposure at each temperature. These periods varied from 1/3 to 7 hours. The same grades as shown in Fig. 3 were tested, and the test specimens were the same size as previously used.

These grades, shown in Fig. 4, are arranged in the same order as those in Fig. 3, but instead of showing a gradual increase in blistering temperature from top to bottom, it will be seen that a number of the grades showing relatively high blistering temperature under rapid rate of rise now blister at much lower temperatures when exposed for longer periods. Conversely, some of the grades are improved in blistering temperatures. This is probably due to elimination of some volatile constituents by the longer exposure at lower temperatures. The grades showing marked improvement are in general higher resin content cotton-fabric-base types.

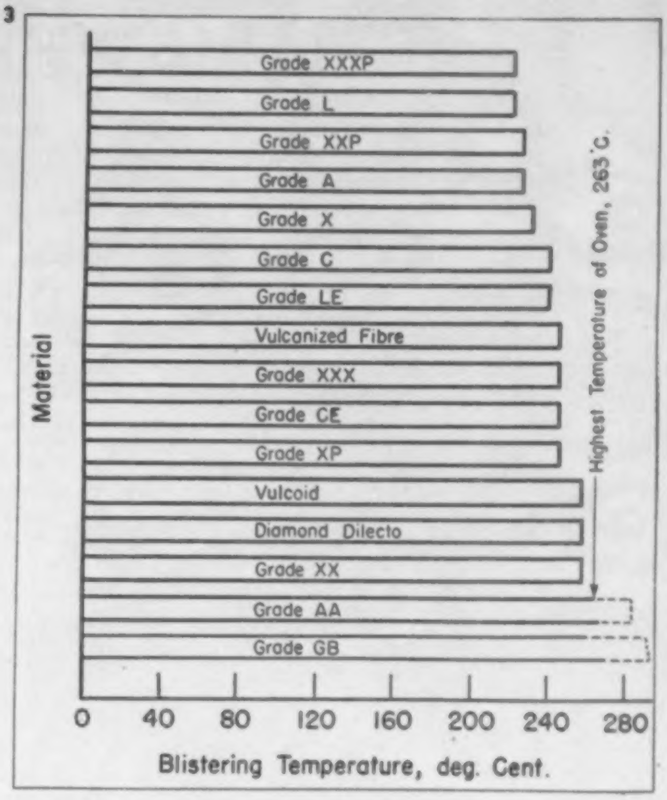
It is recognized that the size of the test specimen has a marked effect on the blistering temperature. This is probably due to the fact that volatile constituents in many grades can more readily escape from the cut edges than from the pressed surfaces.

## Dimensional and flexural strength changes at 225° C.

Some of the grades showing up best in the step-by-step blistering test were heated at 225° C. up to 14 hr. and measurements of dimensional changes were made. These changes, lengthwise, crosswise and in thickness, are shown in Table IV and Fig. 5, 6 and 7.

Fabric-base grades CE and LE show a greater change (shrinkage) lengthwise than grades XXP and AA and con-

3

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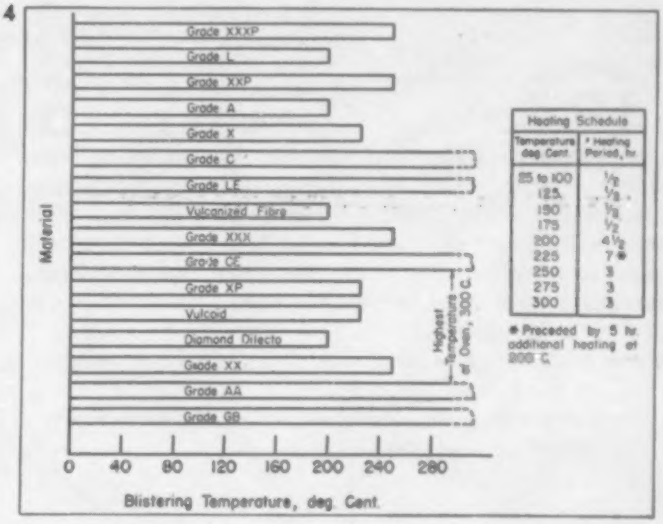


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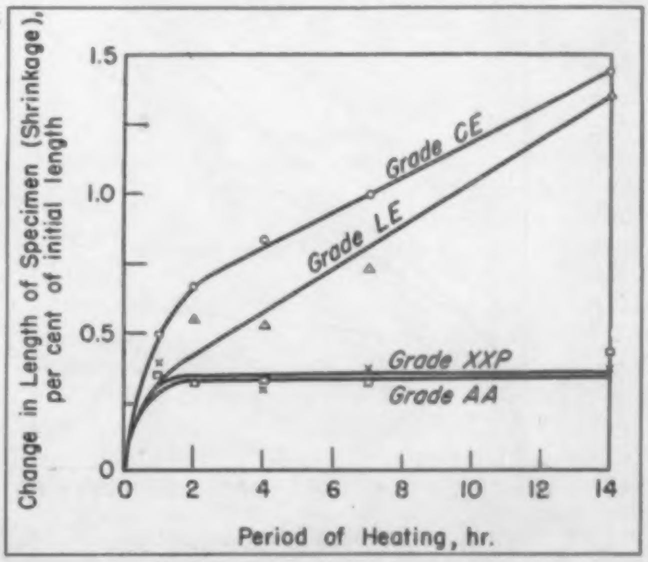


*3—Effect on materials of a constant rate of rise of temperature to 263°C. in a period of 45 minutes. 4—Effect of increase in temperature increments of 25°C. with various periods of exposure at each temperature. 5—Effect on length of heating at 225°C. for up to 14 hours*

TABLE V.—FLEXURAL STRENGTH[a] OF PHENOLIC LAMINATES HEATED AT 225° C.

| Grade | Value | Flexural strength after heating for: 0 hr. | 1 hr. | 2 hr. | 4 hr. | 7 hr. | 14 hr. |
|---|---|---|---|---|---|---|---|
| XXP | Ultimate, p.s.i. | 14,000 | 12,100 | 9,700 | 10,600 | 11,500 | 7,800 |
| | Percent of initial | 100 | 86.4 | 69.1 | 75.7 | 82.1 | 55.4 |
| CE | Ultimate, p.s.i. | 21,000 | 11,300 | 9,850 | 6,960 | 5,000 | 3,120 |
| | Percent of initial | 100 | 53.8 | 46.9 | 33.1 | 23.9 | 14.9 |
| LE | Ultimate, p.s.i. | 16,900 | 9,080 | 5,860 | 5,390 | 5,480 | 3,430 |
| | Percent of initial | 100 | 53.7 | 34.7 | 31.9 | 32.4 | 20.3 |
| AA | Ultimate, p.s.i. | 22,800 | 15,700 | 16,000 | 12,300 | 17,200 | 16,000 |
| | Percent of initial | 100 | 68.9 | 70.2 | 54 | 75.4 | 70.2 |

[a] Tests made at 25° C. on lengthwise specimens cooled to that temperature.

TABLE VI.—EFFECT OF HEAT ON THE FLEXURAL STRENGTH AND IMPACT STRENGTH OF PHENOLIC LAMINATES MADE FROM GRADE AA AND UNDERWRITERS GRADE ASBESTOS CLOTH[a]

| Material | Exposure treatment prior to test | Ultimate flexural strength Lengthwise | Crosswise | Edgewise Izod impact strength Lengthwise | Crosswise |
|---|---|---|---|---|---|
| | | p.s.i. | p.s.i. | ft.-lb./in. of notch | ft.-lb./in. of notch |
| AA fabric (90 percent asbestos—10 percent cotton) | As received | 24,800 | 19,800 | 5.16 | 4.28 |
| | 48 hr. at 135° C. | 27,500 | 19,500 | 5.22 | 4.53 |
| | 1 hr. at 205° C. | 26,800 | 19,200 | 5.09 | 4.31 |
| | 7 days at 160° C. | 25,600 | ... | 5.15 | .... |
| Underwriters fabric (80 percent asbestos—20 percent cotton) | As received | 23,200 | 23,000 | 4.11 | 3.28 |
| | 48 hr. at 135° C. | 26,700 | 19,400 | 3.30 | 2.80 |
| | 1 hr. at 205° C. | 24,800 | 18,800 | 3.14 | 2.67 |
| | 7 days at 160° C. | 24,200 | 20,100 | 2.58 | 1.98 |

[a] AA tests were based on $^1/_{16}$ in. thickness, and Underwriters Grade on $^1/_8$ in. thickness excepting the "as received" which were $^1/_4$ in. in thickness. The specimens at the high temperatures were given the 48-hr. treatment at 135° C. prior to exposure at the high temperatures.

tinue to shrink with time. Grades XXP and AA remain constant after the first hour for this lengthwise change. It will be seen from the curves of dimensional change that shrinkage in the crosswise direction is greater in actual value than that in the lengthwise direction, for both cotton-fabric and paper-base grades. The asbestos-base material shows practically the same value in both directions. In Fig. 7 it will be noted that the cotton-fabric and asbestos-base grades showed an increase in thickness while the paper-base grade showed a shrinkage or decrease in thickness.

Considering the dimensional changes as a whole, the asbestos-base grade is the most stable, probably because of the lower resin content of the material and the greater stability of the inorganic base filler. (*Please turn to page 190*)

***6 and 7—Effect of heating at 225°C. for periods ranging up to 14 hr. on length and thickness of specimens being tested***

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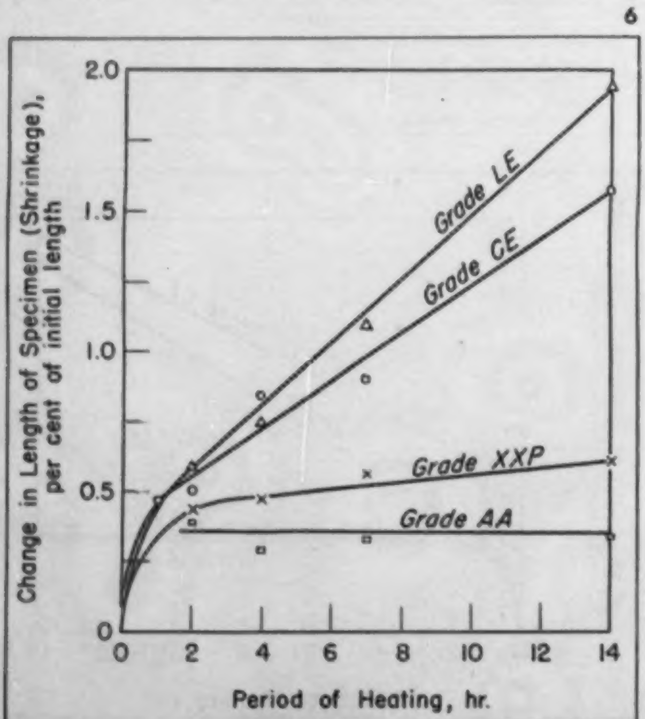


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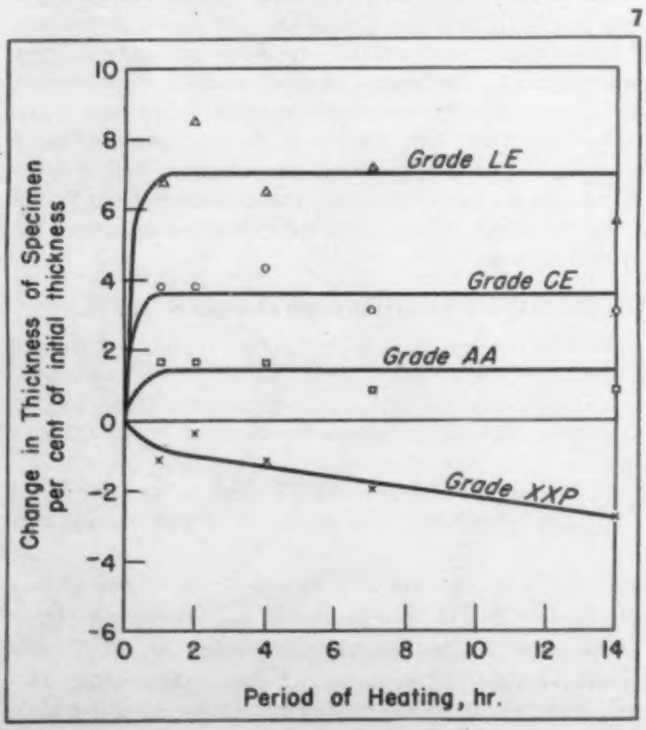


# Diffusion of water through plastics*

by G. DEEG, JR., and C. J. FROSCH†

THE rapid strides in the chemical development of synthetic resins have resulted in a steady stream of new products for molding, wrapping and coating. Although suitable for many other uses, these materials are principally in demand as moisture-resistant products, i.e., materials that are relatively impermeable to water vapor. For many electrical purposes the diffusion of even small amounts of water is objectionable, but can be tolerated. On the other hand in the packaging of food stuffs, etc., the moisture permeability generally is not quite so critical.

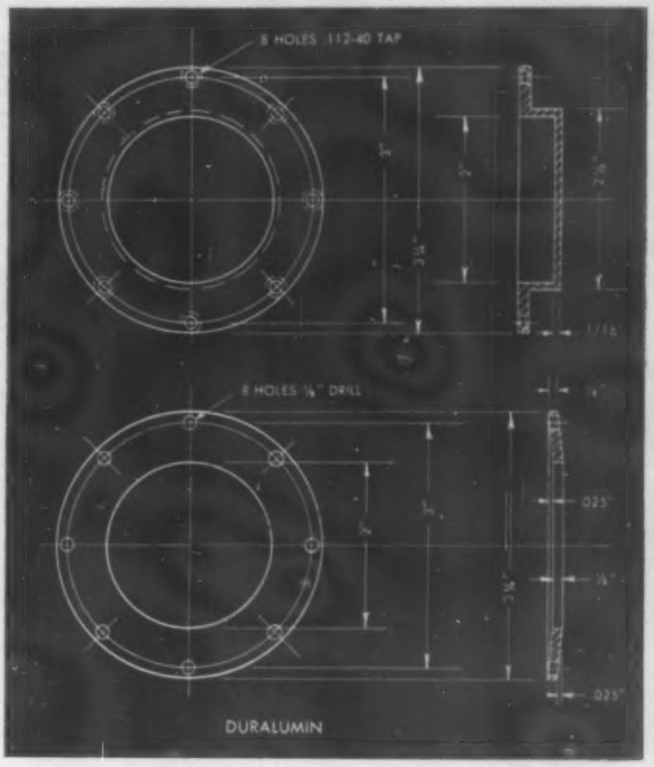
At the time this work was initiated no standard method was available in the plastics industry for measuring moisture permeability. This was due not only to the large variety of materials to be covered by such a test but also to the diversity of usages for which the materials were intended. More recently this situation has been changed by the adoption of a tentative standard method.[1]

Although permeability data were available on a large number of materials, a correlation of the results on some common basis for comparison was not possible because of the large number of variables involved, either indeterminate or unreported. Lack of information regarding the composition of the materials tested also limited the value of much of the published data. Permeability data on a number of plastic materials were desired not only to supplement other physical data but to permit a study of some of the factors which govern permeability in plastics.

## Procedure for determining permeability

A constant-pressure diffusion cell is used having the dimensions given in Fig. 1. However, in cases where sufficiently large specimens cannot be prepared, a similar cell having a diameter of $1^9/_{16}$ in. is used. The principle of this cell is similar to those shown in A.S.T.M. method D 697-42 T.

The assembled cell, filled with water to within $^1/_4$ in. of the under surface of the specimen, is placed in a desiccator containing phosphorus pentoxide or calcium chloride and maintained at a constant temperature of 25° C. Leakage is avoided by using polyisobutylene-coated silk gaskets on each side and stop-cock grease on the exposed edge of the specimen. Corrosion of the aluminum cell is prevented by applying several coats of an alkyd varnish. Each coat is thoroughly baked to drive off all volatile constituents before use in the tests.




1—*A constant-pressure diffusion cell. Scale is 1/1*

From the loss in weight of the cell per unit time, the diffusion constant $D$ is calculated as described by Taylor, Herrmann and Kemp,[2] employing Fick's diffusion law as follows:

$$D = \frac{Nx}{At\,(p_1 - p_2)}$$

where $N$ is the number of grams of water which diffuses through a cross-sectional area $A$ (sq. cm.) through a thickness $x$ (cm.) in time $t$ (hr.). Since all the tests are conducted at 25° C., $p_1 - p_2$ is taken as 23.75 mm. Hg. when phosphorus pentoxide is the desiccant and 23.50 when calcium chloride is used. The constant $D$ thus indicates the number of grams of water per hour which will pass through a 1-cm. cube of the plastic under a vapor-pressure difference of 1 mm. Hg.

Each cell is run until a constant value of $D$ is obtained in order to be certain that the specimen is in equilibrium with respect to sorption. This may require from 3 days to several months, depending on the thickness, water sorption and permeability of the specimen. It is essential to renew

TABLE I.—DIFFUSION CONSTANTS OF SOME TYPICAL BASIC PLASTICS

| *Material* | $D \times 10^{-8}$ |
|---|---|
| Phenol-formaldehyde resin | 0.1 |
| Polyethylene | 0.2 |
| Polyvinyl chloride | 0.5 |
| Polydecamethylene sebacamide | 0.8 |
| Polystyrene | 3.5 |
| Polymethyl methacrylate | 4.1 |
| Polyethylene sebacate | 7.7 |
| Polyamide (6–6) | 11.2 |
| Polyvinyl acetate | 30.0 |
| Cellulose acetate butyrate | 52.0 |
| Cellulose triacetate | 71.0 |
| Ethyl cellulose | 77.0 |
| Cellulose acetate propionate | 102.0 |
| Cellulose acetate | 114.0 |

* Presented at the A.S.T.M. Symposium on Plastics held in Philadelphia, Pa., on Feb. 22–23, 1944, and published here through the courtesy of the American Society for Testing Materials.
† Bell Telephone Laboratories, Inc.
[1] A.S.T.M. Method D 697–42 T for "Water Vapor Permeability of Plastic Sheets."

[2] R. L. Taylor, D. B. Herrmann and A. R. Kemp, Ind. Eng. Chem. *28*, 1255 (1936).

Table II.—Diffusion of Water Through Various Plastics at 25° C.

| *Material* | *Thickness* | *Diffusion constant* |
|---|---|---|
| | *cm.* | *D × 10⁻⁸* |
| Polyester and polyamide types | | |
| Polyethylene sebacate, cast | 0.0386 | 7.55 |
| | 0.0480 | 6.95 |
| | 0.0942 | 7.92 |
| | 0.1005 | 7.91 |
| Acetylated polyethylene sebacate, cast | 0.0217 | 7.18 |
| | 0.0845 | 7.21 |
| Poly 4-ethylene 1-propylene 5-sebacate, cast | 0.0569 | 10.02 |
| | 0.0821 | 10.03 |
| Polydecamethylene sebacamide, cast | 0.0261 | 0.92 |
| | 0.0327 | 0.73 |
| Poly 9-ethylene 1-decamethylene 9-sebacate 1-sebacamide, cast | 0.0455 | 15.0 |
| | 0.0838 | 18.0 |
| Polyamide (6–6 Du Pont) | 0.0427 | 11.30 |
| | 0.0498 | 11.03 |
| Polyvinyl chloride and copolymers | | |
| Koroseal 12102, molded | 0.0630 | 3.50 |
| Koroseal 14, molded | 0.0627 | 4.97 |
| Koroseal 14, rolled | 0.0113 | 4.68 |
| Koroseal 14, rolled | 0.0062 | 4.36 |
| Koroseal 14, cast, dusted with polyvinyl chloride | 0.0050 | 2.38 |
| Koroseal 67, molded | 0.0632 | 8.85 |
| Koroseal 125, molded | 0.0615 | 2.64 |
| Koroseal 541, molded | 0.0576 | 3.83 |
| Koroseal 763, molded | 0.0607 | 0.60 |
| Koroseal 1033, molded | 0.0588 | 3.51 |
| Koroseal 23 DV-67, molded | 0.0408 | 9.81 |
| Koroseal 23 DV-673, molded | 0.0358 | 9.55 |
| Koroseal 23 DV-1208, molded | 0.0645 | 13.17 |
| Koroseal 23 DV-1209, molded | 0.0480 | 29.5 |
| Polyvinyl chloride, molded | 0.0950 | 0.46[a] |
| Polyvinyl 95-chloride 5-acetate, molded | 0.0524 | 0.70 |
| Polyvinyl 95-chloride 5-acetate, 60 percent inorganic fillers, 10 percent Tricresyl phosphate, 30 percent | 0.0513 | 2.73 |
| Santicizer M17, 30 percent | 0.0398 | 4.43 |
| Dioctyl phthalate, 30 percent | 0.0543 | 4.65 |
| Flexol 3GH, 30 percent | 0.0534 | 36.45 |
| Polyvinyl 87-chloride 13-acetate, molded | 0.0492 | 1.12 |
| Vinyl, commercial sheet | 0.0131 | 1.20 |
| | 0.0524 | 1.10 |
| Polyvinyl acetate, molded | 0.0442 | 29.9 |
| Butvar 29/95 (aldehyde-vinyl), molded | 0.0962 | 6.43 |
| Cellulose derivatives | | |
| Cellulose acetate A-17 (unplasticized), molded | 0.0979 | 114.0[a] |
| Cellulose acetate A-17 (unplasticized) acetone cast | 0.0402 | 287.0[a] |
| | 0.0450 | 310.0[a] |
| Cellulose acetate, commercial sheet | 0.0030 | 36.1[a] |
| | 0.0136 | 34.2[a] |
| | 0.0542 | 38.4[a] |
| Cellulose triacetate (unplasticized), molded | 0.1027 | 71.2 |
| Cellulose acetate butyrate, molded | 0.0950 | 52.2[a] |
| Cellulose acetate propionate, molded | 0.0976 | 101.8[a] |
| Ethyl cellulose (unplasticized), molded | 0.1005 | 76.8 |
| Ethyl cellulose (plasticized), molded | 0.0601 | 16.0 |
| Ethyl cellulose, commercial sheet | 0.0185 | 78.3[a] |
| Cellulose nitrate, commercial sheet | 0.0387 | 22.5[a] |
| Regenerated cellulose (viscose), moisture-proof | 0.0025 | 0.93[a] |
| Miscellaneous materials | | |
| Polystyrene (unplasticized), molded | 0.106 | 3.50[a] |
| Polystyrene, commercial sheet | 0.0028 | 2.75[a] |
| Methyl methacrylate A (unplasticized), molded | 0.1080 | 4.07 |
| Methyl methacrylate B (unplasticized), molded | 0.109 | 4.01 |
| Urea-formaldehyde, laminated | 0.1043 | 46.7[a] |
| Phenol-formaldehyde (unfilled), molded | 0.0974 | 0.11 |
| Polyethylene, molded | 0.0399 | 0.23 |
| Rubber, cable bandage | 0.0897 | 8.37 |

[a] Calcium chloride.

the desiccant frequently and to avoid excessive amounts of moisture transfer by limiting the cells per desiccator.

## Discussion of results

The diffusion data for a number of plastic materials are given in Table II. It should be noted that none of the materials tested is totally impermeable to water vapor. There is also agreement with Fick's law in that the constant $D$ is independent of the specimen thickness.

The data in Table I illustrate how the chemical composition of polymeric materials affects their permeability to water vapor. These materials are unplasticized but may contain small amounts of materials other than polymer. The phenol-formaldehyde resin contains about 1 percent of metallic soap or wax which is added as a mold lubricant.

The data given in Table III illustrate the effect of variations in the concentrations of copolymer components, in this case vinyl acetate and vinyl chloride.

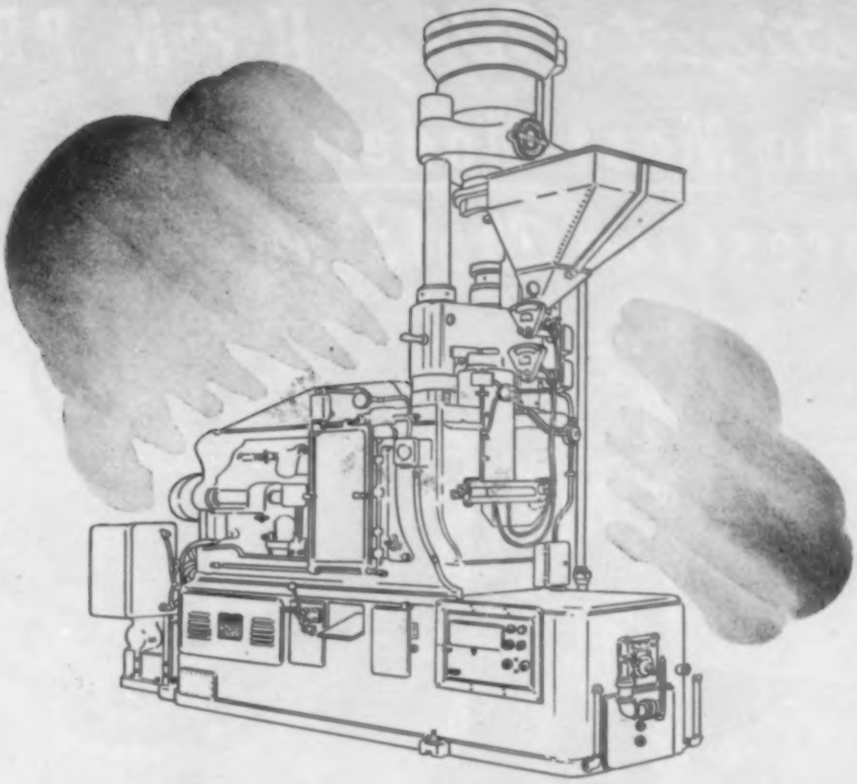
The unplasticized cellulose derivatives as a class generally are very permeable to water vapor (*Please turn to page 198*)

Table III.—Variation of the Diffusion Constant with Copolymer Components

| *Material* | *D × 10⁻⁸* |
|---|---|
| Polyvinyl chloride | 0.5 |
| Polyvinyl 95-chloride 5-acetate | 0.7 |
| Polyvinyl 87-chloride 13-acetate | 1.1 |
| Polyvinyl acetate | 29.9 |

Table IV.—Water Permeability of Unplasticized Cellulose Derivatives

| *Material* | *D × 10⁻⁸* |
|---|---|
| Cellulose acetate butyrate | 52.0 |
| Cellulose triacetate | 71.0 |
| Ethyl cellulose | 77.0 |
| Cellulose acetate propionate | 102.0 |
| Cellulose acetate | 114.0 |



# TECHNICAL BRIEFS

**Abstracts of articles on plastics in the world's scientific and engineering literature relating to properties and testing methods, or indicating significant trends and developments.**

## Engineering

PENETRATION OF PACKAGING MATERIALS BY INSECTS. E. O. Essig, W. M. Hoskins, E. G. Linsley, A. E. Michelbacher and R. F. Smith. J. Econ. Entomol. *36*, 822–9 (Dec. 1943). Various packaging materials, untreated and treated with chemical repellents, were tested to determine resistance to penetration by insects. None of the materials tested proved to be strictly insect proof. The most promising was heavy cardboard double-dipped in thermoplastic. Heavy regenerated cellulose sheets were more resistant than the lighter materials. Kraft-asphalt-leadfoil-cellophane bags have poor resistance. Food odors, thin materials, rough spots, creases and folds are not favorable to insect repellence. The most potent chemical repellents for treating packaging materials are benzyl disulfide, thialdine, 4, 6-dinitro-o-cresol, 2-chloro-6-phenylphenol and 2, 6-dimethylnaphalene.

TENTATIVE CODE FOR THE PREVENTION OF DUST EXPLOSIONS IN THE PLASTICS INDUSTRY. 21 pp. (May 1944). Recommended practices for preventing dust explosions in plants using plastics are described. Data on ignition temperature, minimum energy required for ignition, minimum explosive concentration, maximum pressure and rate of pressure rise for dust clouds consisting of plastics and various other materials used in the plastics industry are given. Copies of the pamphlet may be obtained from the National Fire Protection Assoc., 60 Batterymarch St., Boston 10, Mass., for 25 cents.

NEW COMPOSITIONS FOR LUTING CHEMICAL APPARATUS. A. I. Rychkov and S. Z. Kagan. Khimicheskaya Prom. *1944*, No. 1, 19–21; Chem. Abstracts *38*, 3746–7 (July 20, 1944). Plastic compositions suitable for making gaskets and sleeves for chemical equipment are reported. These materials must be resistant to chemicals. One composition consists of 62 parts polyvinyl chloride, 22 parts dibutyl phthalate and 16 parts graphite; another consists of 100 parts polyvinyl chloride, 60 parts dibutyl phthalate, 40 parts powdered asbestos and a small amount of calcium stearate. Sovprene rubber is also suitable. It is resistant to oils, hydrocarbons, glycerol and alcohols at temperatures between –55 to 120° C. under a wide range of pressures.

PLASTIC IMPREGNATION OF MAGNESIUM CASTINGS. Iron Age *154*, 63 (Aug. 10, 1944). The small holes in magnesium castings are filled with a synthetic resin to render them impregnable to gases and lubricating oils. The impregnating compound consists of a synthetic resin which is copolymerized with styrene. The castings are placed in a tank, a vacuum of 27 in. is applied to remove the air from the small pores, the resin-styrene liquid mixture is then run in, and a pressure of 90 p. s. i. is applied to force the liquid into the castings. On removal the castings are cleaned with kerosene and the resin cured under an air pressure of 50 to 75 p. s. i. at a temperature of 275° F. Impregnated castings are readily machined. The cured resin is resistant to gasoline and hot oils, but is attacked by aromatic solvents.

## Chemistry

POLYMERIZATION OF VINYL ISOBUTYL ETHER. M. F. Shostakovskiĭ and F. P. Sidel'kovskaya. J. Gen. Chem. (U. S. S. R.) *13*, 428–35 (1943); Chem. Abstracts *38*, 3386–7 (July 10, 1944). The polymerization of vinyl isobutyl ether is controllable when stannous chloride is used as a catalyst. The ether was mixed with 0.2 percent stannous chloride, cooled to –17° C. for 3 to 4 hr. and then allowed to become warm. The polymerization reaction was apparent with the evolution of heat. The resin was freed of monomer by heating or drying in vacuo. The polymer is soluble in benzene, carbon tetrachloride and acetone; it is insoluble in alcohol and water. The average molecular weight was 2000. By precipitation from benzene solution by methyl alcohol, the polymer was separated into 6 fractions, the molecular weights of which ranged from 4710 to 1180. Oxidation of the resin with nitric acid yielded oxalic acid; hydrolysis by sodium isobutylate gave polyvinyl alcohol. The resin was unaffected by dilute hydrochloric and sulfuric acids.

NITRATION OF CELLULOSE IN THE VAPOR OF NITRIC ACID. G. L. Wilson and F. D. Miles. Trans. Faraday Soc. *40*, 150–63 (May 1944). A study has been made of the nitration of ramie cellulose in the vapor of nitric acid at pressures of from 4 to 16 mm. of mercury and at temperatures of 20 and 40° C. The weighed bundle of ramie was suspended on a quartz-spring balance and a stream of nitric acid vapor was passed through it at the desired pressure. Experiments were carried on for each chosen pressure and temperature for various times up to 40 hr., and at the end of each run the product was analyzed and the degree of nitration found. An absorption of nitric acid on the cellulose fibers takes place and is at a maximum in about 3 hours. The nitration reaction is a consequence of this absorption and attains its greatest rate about the same time that the absorption reaches its maximum. The rate of nitration is independent of the pressure of nitric acid vapor in the gas-phase but is related to the amount of acid which is absorbed without chemical reaction. The rate of nitration is roughly proportional to the square of this absorbed amount. From this it is inferred that two molecules of nitric acid are concerned in the conversion of a hydroxyl group—one to nitrate it, the other to accept the water of reaction. Cellulose nitrate prepared in this way contained up to 13.4 percent nitrogen.

ESTERS OF DIMETHYLOL UREA AND THEIR TRANSFORMATION INTO RESINS. G. S. Petrov and V. I. Itinskiĭ, J. Chem. Ind. (U.S.S.R.) *18*, No. 8, 15-20 (1941); Chem. Abstracts *38*, 3384 (July 10, 1944). Diethyl ester of dimethylol urea is prepared by dissolving the dimethylol urea in ethyl alcohol and heating at 80° C. for 5 minutes. The butyl ester is obtained by heating dimethylol urea in 12 parts of butyl alcohol at 100° C. for 5 minutes. Addition of silver carbonate, hydrochloric acid, sulfuric acid, zinc chloride, calcium chloride phosphoric acid, benzoic acid, phthalic anhydride and urea nitrate leads to resin formation. Heating the esters at 120 to 130° C. for 8 to 10 min. leads to the formation of brittle insoluble, thermoset resins.

THE POLYMERIZATION OF STYRENE IN PHENOLIC SOLVENTS. C. Walling. J. Am. Chem. Soc. *66*, 1602–6 (Sept. 1944). The rate of polymerization of styrene at 131° C. was measured in a number of phenolic solvents. The rate is affected by air and by benzoquinone and bears no simple relation to the acid strengths of the phenols as measured in water. The polymer is of low molecular weight. In thymol the rate is third order in respect to styrene and inversely proportional to the concentration of thymol. In *m*–cresol

the rate lies between the second and third order. These results are interpreted on the basis that the polymerization is of the uncatalyzed, free radical type, somewhat inhibited by the phenolic solvent; and that this inhibition takes place through a chain transfer reaction yielding relatively unreactive solvent radicals. No evidence is found that the polymerization involves a carbonium ion. Cresol was found to destroy benzoyl peroxide. This observation is used to explain the inhibition of the benzoyl peroxide catalyzed polymerization of styrene by this plastic solvent.

### Properties

PHYSICAL-CHEMICAL PROPERTIES OF TEXTILE NYLON YARNS. Rayon Textile Monthly *25*, 169–71, 221–23 (Apr., May 1944). The properties of nylon yarns now available are presented. These include tensile strength and elongation, chemical resistance, abrasion resistance, density, elastic recovery, delayed recovery, modulus of elasticity, flammability, heat resistance, effect of extreme cold, resistance to attacks by insects, fungi and microorganisms, resistance to marine deterioration and fouling, effect of light, moisture regain, shrinkage and swelling, water extractables and toxicological properties.

CHARACTERISTICS OF PHENOLIC LAMINATES. D. W. Brown. Plastics (London) *8*, 177-86 (Apr. 1944). The methods of manufacture, properties and applications of phenolic laminates are described. The effect of resin content on the physical properties, creep, cold flow, fatigue properties and dimensional stability of paper and fabric-base laminates are compared.

SOME RHEOLOGICAL PROPERTIES OF POLYVINYL CHLORIDE. L. Bilmes. J. Soc. Chem. Ind. *63*, 182–5 (June 1944). The rheological properties of plasticized polyvinyl chloride were studied in a specially constructed torsion apparatus over the temperature range –70 to 100° C. The results obtained were analyzed by means of the Nutting equation and their significance is related to considerations of molecular structure. On raising the temperature from –70 to 140° C. the material passes through 4 states: glassy, leathery, rubbery and plastic. It is possible to characterize these states by values of the constants of the Nutting equation.

EFFECT OF CHEMICAL STRUCTURE ON MECHANICAL PROPERTIES OF PLASTICS AT LOW TEMPERATURE. K. H. Hauck. Kunststoff-Tech. u. Kunststoff-Anwend. *12*, 215–29 (1942); Chem. Abstracts *38*, 3748 (July 20, 1944). The modulus of elasticity, flow, plastic deformation, flexural strength, impact strength, heat resistance and scratch resistance of phenolic resin polyvinyl chloride, polystyrene and cellulose triacetate containing 0 to 40 percent plasticizer were determined over the temperature range –70 to 20° C.

### Testing

SERVICEABILITY OF PLASTIC GEARS. Plastics (London) *7*, 562–8, 578 (Dec. 1943); WEAR TEST ON GEARS. Plastics (London) *8*, 84–7 (Feb. 1944). This is a summary of an article by Opitz and Reese in "Kunststoffe" *32*, 263 (1942) and one by Ulrich and Müller in "Kunststoffe" *32*, 270 (1942) on a study of the static strength, dynamic strength and wear resistance of gears made from various grades of fabric laminated phenolic plastics and various grades of compressed laminated phenolic resin-bonded beech veneers. The compressed laminated wood gears were superior to the other materials in static bend strength, in dynamic bend strength, in impact strength and in wear resistance. On one type of gear the values for static bend strength, dynamic bend strength and impact strength were as follows: 1338 kg./cm.$^2$, 375 kg./cm.$^2$ and 31 cm.-kg./cm.$^2$, respectively, for a coarse fabric laminate containing 40 percent resin; 1378 kg./cm.$^2$, 412 kg./cm.$^2$ and 26 cm.-kg./cm.$^2$, respectively, for a coarse fabric laminate containing 50 percent resin; 1554 kg./cm.$^2$, 412 kg./cm.$^2$, and 27 cm.-kg./cm.$^2$, respectively, for a fine fabric laminate containing 50 percent resin; 1878 kg./cm.$^2$, 900 kg./cm.$^2$ and 100 cm.-kg./cm.$^2$, respectively, for beech veneers bonded with phenolic-resin glue film and containing 4.2 percent resin. A study of the worn gears shows that wear is mainly caused by sliding friction at the middle of the top and bottom teeth. The rolling friction has no influence on wear as long as the load is not high and the contact ratio is not more than two. Details of manufacture of the plastic materials and testing methods are described.

EXPERIMENTAL STRESS ANALYSIS. British Plastics *16*, 199–202 (May 1944). The use of transparent plastic models for experimental stress analysis by photo-elastic methods is described. American practice in determining stresses in automotive engine parts is considered in detail.

OSMOMETRY OF HIGH-POLYMER SOLUTIONS. APPARATUS. R. H. Wagner. Ind. Eng. Chem. Anal. Ed. *16*, 520–3 (Aug. 1944). A glass osmometer of simple design is described. This instrument is suitable for osmotic pressure measurements of high polymer solutions which tend to form a stable foam. The assembly and operation of the osmometer is also described. The uncertainty in aqueous systems is approximately 10 percent at a number average molecular weight of 70,000 and increases to more than 50 percent at 225,000. The reproducibility of measurements of organic liquid systems is 2 to 3 times better, and therefore a large range of molecular weights can be determined with an accuracy of 10 percent or less.

### Synthetic Rubber

GR-S, AN ELASTICALLY INVERTED POLYMER. H. A. Braendle and W. B. Wiegand. J. Applied Phys. *15*, 304–8 (Apr. 1944). The elasticity of GR-S stretched to near rupture was studied. GR-S is more elastic at high elongations, i. e., in the region of strain antecedent to tear or rupture, than natural rubber. The hysteresis of GR-S at low elongations is greater than that of natural rubber. It is concluded that the hysteresis of GR-S at low elongations must be reduced so that tires will run cooler, and that the hysteresis at higher elongations must be increased so that it will relax under these higher amplitude flexures and so prevent premature flex cut failure.

THE USE OF SYNTHETIC RUBBERS IN MOLDED PRODUCTS. M. J. Sanger. India Rubber World *110*, 167–71 (May 1944). The properties of synthetic rubbers are discussed from the viewpoint of their use in molded products. GR-M (neoprene) can be formulated to give a Shore durometer-hardness range in molded products of from 40 to 95. Satisfactory GR-S compounds are available in the range of 45 durometer to hard rubber. Natural rubber has a somewhat wider range than either due to the fact that compounds from 30 durometer to hard rubber are available. Maximum tensile strength values of 3000 lb./in.$^2$ may be obtained with reenforced GR-S compounds, although not in all hardness values as with natural rubber. GR-M compounds may give 3500 to 4000 lb./in.$^2$; 4500 lb./in.$^2$ tensile strength may be obtained with natural-rubber compounds. GR-M compounds will support heavy loads in compression and will suffer only slightly more permanent deformation than similar natural rubber compounds. GR-S compounds undergo considerably more permanent deformation than GR-M or natural-rubber compounds at normal temperatures, but are less affected by elevated temperatures. The shearing strength of both GR-S and GR-M is inferior to that of good natural-rubber stocks. GR-M compounds possess better heat resistance than natural-rubber compounds. However natural rubber is much more satisfactory

at low temperatures. The crystallizing effect after continued exposure to low temperatures is observed with both GR-M and natural rubber, but it is far more pronounced with the former. Plasticizer addition definitely improves the properties of GR-M compounds at low temperatures. However they do show a progressive increase in hardness with a drop in temperature. GR-S compounds are also better than natural rubber in resistance to the deteriorating effect of high temperatures, although not so good as GR-M. Low-temperature flexibility can be obtained in GR-S compounds by the addition of special plasticizers. In abrasion resistance GR-S compounds are in general equal to or better than natural rubber. Yet where severe chipping or cutting is involved, GR-S is usually unsatisfactory. For such severe conditions GR-M compounds are usually specified. When abrasion together with exposure to oil is encountered, GR-M gives more satisfactory service than either natural rubber or GR-S. In service involving weathering and the action of ozone, GR-M is much better than either GR-S or natural rubber. But the weathering properties of GR-S compounds can be improved greatly by the addition of waxes such as have been used successfully with rubber. Of the general-purpose synthetics, GR-M is the only one having good oil or solvent resistance. It is quite satisfactory under moderate oil conditions. GR-S compounds do not swell so much as natural rubber, but their tensile strength and tear-resisting properties deteriorate rapidly. For water and steam resistance GR-S compounds are somewhat better than GR-M. Chemical resistance is dependent on the specific chemicals encountered and requires individual analysis of the problems involved. GR-S compounds are in general not very satisfactory where severe flexing is encountered. More heat is generated in the material itself owing to the flexing. Also, when slight cracks develop, failure often results. GR-M compounds are reasonably satisfactory in flexing service. Both GR-S and GR-M compounds are definitely inferior to natural rubber in regard to resilience. In compounds of the same hardness, GR-M stocks show from 80 to 90 percent and GR-S stocks show from 60 to 70 percent of the resilience of natural-rubber stocks as measured by rebound on a Goodyear-Healy pendulum. GR-M compounds are superior to either GR-S or natural rubber in flame resistance. Data on the adhesion to metals and on the properties of special purpose synthetic rubbers are reported.

EFFECT OF ELASTOMER CRYSTALLIZATION ON TESTS FOR FREEZE RESISTANCE. D. B. Forman. Ind. Eng. Chem. *36*, 738–41 (Aug. 1944). During long exposures to moderately low temperatures, Neoprene Type GN and rubber show a delayed stiffening that usually begins after 24 to 48 hours. This is caused by crystallization of the elastomer. The degree of crystallization under proper conditions is a function of the state of cure. The magnitudes of the increases in hardness are dependent upon the filler and softener content of the elastomer. Neoprene Type FR and GR-S do not show crystallization effects. Compounds of Neoprene Type FR containing certain softeners may undergo delayed stiffening. This is believed to be caused by plasticizer incompatibility at low temperatures. Some Neoprene Type GN compounds show the same effect.

A NEW APPARATUS FOR DETERMINING HARDNESS AND CREEP OF SYNTHETIC AND NATURAL RUBBER COMPOUNDS AT VARIOUS TEMPERATURES. J. A. Talalay and R. E. Gladstone. Rubber Age *55*, 147-52 (May 1944). The ring modulus hardness tester which evaluates the hardness and creep of elastomers by measuring the modulus of elasticity of ring specimens at small deformations is described. The measurements can be made at any desired atmospheric conditions; the instrument has been used satisfactorily between –70 and +150° C. The test is practically independent of the surface characteristics of the compound. The instrument is comparatively sensitive and the personal factor is largely eliminated. A large number of samples may be evaluated rapidly under widely variable conditions. Data obtained with several rubbers are reported.

NEW SYNTHETIC RUBBER COMPOUND FOR SEALING FUEL TANKS. I. Fuller. Aero Digest *45*, 98, 100 (May 15, 1944). A thiokol-latex base-rubber compound for sealing fuel tanks is described. The compound has good adherence to aluminum, is resistant to water and salt spray, has satisfactory aging characteristics and behaves satisfactorily when subjected to pulsating loads.

SYNTHETIC RUBBER APPLICATIONS ON AIRCRAFT ENGINES. G. H. Spremulli. SAE J. *52*, 255-75, 280 (June 1944). An outline of the procedure involved in selecting a suitable synthetic rubber for aircraft-engine applications is presented. This procedure includes the application analysis and the laboratory testing of synthetic rubber stocks and finished parts. Analyzing the requirements of the application involves consideration of various factors such as present operating conditions and also the least favorable conditions that might be encountered in service. The necessary general physical properties and the requirements for resistance to high and low temperatures must be determined for each application and a specification covering these requirements selected. The importance of proper design is emphasized.

STIFFENING EFFECT OF PIGMENTS IN RUBBER. S. D. Gehman. Ind. Eng. Chem. *36*, 715–19 (Aug. 1944). Results of measurements on gum stock in compression, particularly those dealing with the effect of the shape of test piece on stiffness, furnish an explanation of the stiffening effect of pigment loadings. In a loaded stock, films of rubber exist between the pigment particles. The films are attached to the particles and their thickness is of the same order of magnitude as the particle diameter. Under these circumstances it is to be expected that the stiffness of the rubber will be enhanced, and the rubber will be working under conditions analogous to those existing when a test piece in compression has a high-shape factor — i. e., high ratio of load area to free area. The idea is applied to calculate the relative effect of the volume loading of carbon blacks on stiffness in compression. Agreement with experimental curves is good. The theory explains the systematic change in shape of load-compression curves as pigment loading is increased. It accounts qualitatively for the divergence between the dynamic and static modulus for stocks with carbon black loadings. Essentially, the theory seeks to extend the compression results on large-scale test pieces to the microstructure in the loaded stock.

NEOPRENE AND OTHER SYNTHETIC RUBBERS IN THE TEXTILE INDUSTRY. E. H. Krismann. Am. Dyestuff Reporter *33*, 246-251 (June 5, 1944). A brief description of the history of natural and synthetic rubbers and of the properties of synthetic rubbers is given. The application of synthetic rubbers in textile processing equipment is reviewed.

MORPHOLOGY OF LATEX PARTICLES AS SHOWN BY ELECTRON MICROGRAPHS. S. B. Hendricks, S. G. Wildman and H. F. McMurdie. India Rubber World *110*, 297–300 (June 1944). Morphological features of particles from latices of 16 plant species were studied by means of electron micrographs, a number of which are reproduced. The smallest particles have about the volume required to contain a very small number of molecules. Evidence is given for both form-retaining and fluid properties of latex particles. Difficulties with the hypothesis that these particles have fluid interiors covered by a surface film of gel rubber are pointed out. A new hypothesis accounting for the observed properties is advanced. According to it, the latex particles contain rubber molecules entwined as if they were odd lengths of string with other latex constituents held between the meshes.

# PLASTICS DIGEST

**This digest includes each month the more important articles of interest to those who make or use plastics. Mail request for periodicals directly to publishers.**

## General

ANTISCATTER TREATMENTS FOR GLASS. F. W. Reinhart, R. A. Kronstadt and G. M. Kline. National Bureau of Standards Miscellaneous Publication M175, 31 pp. (June 19, 1944). Widespread use of glass in all types of buildings and transportation vehicles presented a critical problem in providing measures for protection against air raids. At the start of the war in this country many different materials and methods were proposed for treating glass to prevent scattering. A vacuum-concussion apparatus was used to test glass treated with lacquers, tapes, plastic films and adhesive-fabric combinations. The materials which gave satisfactory results as initially applied were subjected to wet-dry cyclic and heat tests to determine the aging characteristics of the anti-scatter materials. Only a few materials gave satisfactory results after subjection to the accelerated aging tests. The lacquers which gave "good breaks" after aging were made with polyvinyl butyral. It should be recognized that no anti-scatter treatment can be expected to give complete protection from the hazards of flying glass. The data will be of interest to those concerned with general problems relating to the adhesion of materials to glass. Copies of this publication may be obtained from the Superintendent of Documents, Washington 25, D. C. for 10 cents.

CLASSIFICATION OF SYNTHETIC MATERIALS. R. Lepsius. Kunststoffe *34*, 11–14 (1944); Chem. Abstracts *38*, 3385 (July 10, 1944). This is a general description and classification of high molecular weight materials. The chemical classification and trade names of plastic materials made in Germany are given.

REDUCING WOOL SHRINKAGE AND FELTING WITH MELAMINE RESINS. E. P. Johnstone. Am. Dyestuff Reporter *33*, 301–3 (July 3, 1944). Woolen cloth is treated with catalyzed water-soluble methylated methylol melamine, the excess resin removed, the cloth dried and the remaining resin polymerized at 230 to 300° F. for 4 to 45 minutes. This treatment renders the cloth practically shrinkproof to laundering. The polymerized resin is distributed uniformly throughout the fibers. The resin is between and within the cortex cells of the fibers. In this respect this process differs from others which are characterizd by a modification of the epithelial scale surface of the fiber. Monomethylol urea, dimethylol urea and dimethyl ether of dimethylol urea do not render woolen goods shrinkproof.

POLYVINYL CHLORIDE PASTES AND THEIR PROCESSING. G. Wick and J. Grassl. Kunststoffe *32*, 327–30 (1942); Chem. Abstracts *38*, 3386 (July 10, 1944). Pastes consisting of a mixture of polyvinyl chloride and plasticizers are suitable for coating materials by painting techniques and for forming products by dipping, molding and baking. Maps and overshoes are made by the painting process, overshoes and gloves by the dipping process, stoppers and other solid pieces by the molding process and sponges by the baking process. Damaged articles are readily mended by painting on the paste and welding it on by heat.

STARCH ADHESIVES. L. T. Smith and R. M. Hamilton. Chem. Eng. News *22*, 1482–4 (Sept. 10, 1944). The history of the development of starch adhesives and a discussion of the theories of adhesion are presented. Starch adhesives are used for stamps, envelopes, bottle labels, boxboards, paper finishing, textile finishing, calico printing and paper making. Many types of starch adhesives are made but the majority contain: 1) the active component, which may be raw starch, thin-boiling starch, dextrin, British gum, oxidized starch or enzyme-converted starch; 2) the solvent or medium, which is usually water; 3) modifying agents; and 4) plasticizers. Modifying agents may be caustic soda, urea, formamide, chloral hydrate, inorganic salts, alkali thiocyanates borax, soda ash, methyl Cellosolve, formaldehyde, melamine-formaldehyde resin, urea-formaldehyde resin, sodium cetyl sulfonate, sodium lauryl sulfonate, sodium soaps, substituted aromatic sulfonates, resins, protein glues, rubber latex, fluorides, octyl alcohol and cetyl alcohol. Plasticizers may be glycerol, glycols, urea, sorbitol, castor oil, sodium acetate, sodium lactate, lactic esters, sodium nitrate and alkali thiocyanates. The different types of starches and the methods of preparing them are described briefly. An extensive bibliography is included.

## Materials

POLYTHENE. F. G. Rice. Can. Chem. & Process Ind. *28*, 459–63 (July 1944). Polythene is a light, tough, semi-rigid plastic which possesses outstanding chemical, physical and electrical properties. Its manufacture is dependent on a high-pressure reaction of an order not used commercially heretofore; and the process, while simple in its operation, required the solution of important safety problems before it could be used. The material is highly resistant chemically. It is crystalline in structure and the crystals may be oriented by cold drawing in films and filaments. It possesses good strength and flexibility even at low temperatures. It has high dielectric strength and a very low power loss over a wide range of frequencies. It is recommended as an insulating coating for wires and cables, particularly in the high-frequency field. It may be used like other thermoplastic materials in compression or injection molding processes, and may be cut into sheets by the block method, or extruded from standard extrusion machines either over wire or as rods, tubes or other desired profiles. Thirty-five literature and thirty-five patent references are given.

ANILINE RESINS AND ANILINE-RESIN LAMINATES AS ELECTRIC INSULATING MATERIALS. L. Codolini. Kunststoffe *33*, No. 7, 183–6 (1943); Chem. Abstracts *38*, 3043 (June 20, 1944). Aniline resins have high insulating power and heat resistance. The pure resin has good insulating properties at radio frequencies. The plasticized materials are flexible, easily machined and suitable for low-voltage insulation. Cellulose-filled aniline resins are good high-voltage insulators. Asbestos-filled aniline resins are fireproof and nonhygroscopic. Aniline resins are more suitable than phenolics in transformers and are suitable as replacements for shellac-bonded mica.

CHEMICALLY STABLE MATERIALS FROM POLYATOMIC PHENOLS AND FORMALDEHYDE. V. P. Shishkov. J. Chem. Ind. (U. S. S. R.) *18*, No. 3, 21–8 (1941); Chem. Abstracts *38*, 3385 (July 10, 1944). Resorcinol-phenol-formaldehyde resins filled with graphite become completely cured at 20 to 25° C. and the products have satisfactory chemical stability, hardness and heat conductivity. The rate of resin formation with polyphenols decreases in the following order: 1) resorcinol and pyrogallol, 2) hydroquinone and 3) pyrocatechol. The presence of a group between

the hydroxyl groups results in increased chemical stability. In the formation of resins from a mixture of resorcinol, phenol and formaldehyde, all the resorcinol reacts with formaldehyde before any phenol reacts; the resorcinol-formaldehyde resin is a catalyst for further resin formation.

ACRYLONITRILE - BUTADIENE COPOLYMERS. R. A. Emmett. Ind. Eng. Chem. *36*, 730-4 (Aug. 1944). Mixtures of acrylonitrile-butadiene copolymers (Hycar OR) with plasticized polyvinyl chloride (Geon 102) covering the range of concentrations of polyvinyl chloride from 0 to 100 percent were investigated. These combine, in varying degrees, the sunlight, ozone and aromatic solvent resistance of the polyvinyl chloride with the oil-resistant and thermosetting properties of the Hycar OR. A satisfactory combination of properties was found with a mixture of 75 percent Hycar OR-15 and 25 percent Geon 102. Comparative compounding data are given for Hycar OR-15 and a blend of 75 parts Hycar OR-15, 25 parts Geon 102 and 25 parts tricresyl phosphate. These data show that, in addition to its superiority in sunlight and ozone, the mixture has improved resistance to tearing, flex cracking and aging as compared with Hycar OR-15.

PREFORMED PLASTICS. Iron Age *154*, 56-7 (July 20, 1944). Plastic preforms are made by sucking a suspension of cellulose pulp and phenolic resin in water onto a form made of copper screen — similar to the manner in which paper is made. The water goes through the screen leaving the cellulose-resin mixture on the form. The preform is then placed on heated dies and molded under heat and pressure. The strength properties of the product are similar to those of phenolic laminates.

## Applications

CHLORINATED PARAFFINS. A. E. Irvine. Am. Dyestuffs Reporter *33*, 189-92 (Apr. 24, 1944). Chlorinated paraffins are used to render fabrics fire-, water- and mildew-resistant. Specification requirements and test methods for rate of burning, flexibility, water resistance and mildew resistance are given.

HYDROLYSIS OF LIGNOCELLULOSE. R. M. Dorland. Chem. Eng. News *22*, 1352-6 (Aug. 25, 1944). The Masonite process and the various products made by this process are described in detail. These products include hard boards, die stocks, reflector boards and loft boards.

NORESEAL—A NEW CORK SUBSTITUTE. S. I. Aronovsky, W. F. Talburt and E. C. Lathrop. U. S. Dept. Agr. Bull. AIC-44, 20 pp. (May 1944). The production and properties of Noreseal, a cork substitute made from low-cost domestic agricultural raw materials, are described. Results of tests show that Noreseal is fully equal to cork compositions for sealing beverages in bottles.

SAFETY GLASS FOR AIRPLANES. J. H. Sherts. Aero Digest *46*, 99-101, 137 (Aug. 15, 1944). Windshields made of partially tempered glass with an interlayer of plasticized polyvinyl butyral resin are described. The plastic interlayer is 0.060 or 0.120 in. in thickness and extends beyond the glass to provide a flexible edge for mounting. The edge is stiffened in some types by inserting pieces of thin metal in the plastic. The results of tests made by dropping steel balls varying in weight from ½ to 22 lb. and with an 11-lb. shot bag at 0, 70 and 120° F. to determine resistance to impact, and of burst tests made at 0, 32, 70 and 120° F. are reported.

THERMOPLASTIC CABLES. H. Barron, J. N. Dean and T. R. Scott. J. Inst. Elec. Eng. *91*, Part *2*, 297-309 (Aug. 1944). The present position of commonly used thermoplastic materials in the cable field and the methods of evaluation of suitable insulation and sheathing compounds are reviewed. Although most of the review deals with polyvinyl chloride cables in detail, other thermoplastics such as polythene, ethyl cellulose, polyisobutylene, polystyrene, nylon, cellulose acetate butyrate and polyvinylidene chloride are considered briefly. The evidence leads to the conclusion that thermoplastic compounds can be selected to produce satisfactory wires and cables whose characteristics compare favorably with rubber cables. Oxidation need no longer be considered as the predominant factor in determining life. There are still restricting factors which prevent thermoplastic cables from being used at temperatures appreciably in excess of those suitable for rubber cables. Detailed information on the formulation properties, manufacture, applications and installation of polyvinyl chloride-covered cables is given.

WOOD AND PLASTICS. M. W. Bourdon. Automotive and Aviation Ind. *91*, *25*, 62-4 (Sept. 1, 1944). The British Proctor IV, a trainer plane built chiefly of wood and plastics, is described. Synthetic resins are used as adhesives for bonding the plywood and laminated components, for bonding main structural joints and in the protective coatings.

## Coatings

VINYL RESIN FOR AIR-DRY AND LOW-BAKE COATINGS. A. K. Doolittle and G. M. Powell. Paint Oil Chem. Rev. *107*, 9-11, 40-2 (April 6, 1944). A vinyl resin made by copolymerizing 85 parts vinyl chloride, 15 parts vinyl acetate and 1 part maleic acid gives coatings which adhere well to smooth surfaces after air-drying. The good adhesion is attributed to the presence of unreacted carboxyl groups. The average molecular weight is about 10,000. Other properties are similar to the usual vinyl chloride-acetate copolymers.

PRECIPITATION OF CELLULOSE ACETATE. M. Takei and H. Erbring. Kolloid—Z. *101*, 59-64 (1942); Chem. Abstracts *38*, 3125 (June 20, 1944). The precipitation of cellulose acetate from solutions by non-solvents was studied by titration, viscosity and turbidity methods. The state of solution is better determined with benzene as a precipitant than with heptane or methyl alcohol.

MOISTURE PERMEABILITY OF LACQUER FILMS. E. Rossmann and G. Schultze. Korrosion u. Metallschutz *19*, 13-19 (1943); Chem. Abstracts *38*, 3492 (July 10, 1944). The effects of film structure, temperature, pressure, relative humidity, air motion, composition and thickness on the permeability of lacquer films are discussed. The data indicate that a general rigid mathematical treatment of permeability is practically impossible unless factors are included for all the conditions.

TESTING THE RESISTANCE OF VARNISHES AND COLOR VARNISHES TO RUBBING AND ABRASION. R. S. Dantuma. Polytech. Weekblad *36*, 423-5 (1942); Chem. Abstracts *38*, 3858 (July 20, 1944). A method for determining the abrasion resistance of varnish films is described.

EVALUATION OF LOW-VISCOSITY NITROCELLULOSES IN NON-OXIDIZING ALKYD RESIN LACQUERS. W. Koch. Ind. Eng. Chem. *36*, 756-8 (Aug. 1944). Four low-viscosity cellulose nitrates with viscosities of 19, 27, 33 and 40 centipoises, all below RS ¼-second type, were evaluated in five compositions with each of four commercial nonoxidizing alkyd resins for Sward rocker hardness and for temperature-change resistance after 6 months of weathering at Miami, Fla., and after a combined outdoor exposure of 3 months at Miami and 3 years at Wilmington, Del. The data furnish evidence that satisfactory lacquers of the automobile finishing type can be made by combining cellulose nitrates having viscosities as low as 27 centipoises with nonoxidizing alkyd resins. This limitation does not apply to resins such as drying oil types which are good film formers, where still lower-viscosity cellulose nitrate is used to obtain quick-setting tack-free films.

# U. S. Plastics Patents

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 10 cents each

WATERPROOFED PLASTIC. A. T. Smith (to Sunlite Manufacturing Co.). U. S. 2,355,756, August 15. A conduit formed of flexible plastic material coated on the interior with a waterproof film.

FILTER. E. W. Rugeley (to Carbide and Carbon Chemicals Corp.). U. S. 2,355,822, August 15. A filter comprising filaments of a vinyl halide ester copolymer which have been partly fused.

METAL PLATING. M. Weiss (to Cohan-Epner Co.). U. S. 2,355,933, August 15. Plastic articles are rolled in sand; washed; immersed in a ferrous sulfate solution, then in a copper sulfate solution, then in a bath of water, ethyl alcohol, sulfuric acid, quinol and stannous sulfate; rinsed in water and finally in a bath containing sodium hydroxide, silver nitrate, ammonia and a reducing agent.

PRINTING PLATE. C. E. Boutwell. U. S. 2,355,949, August 15. A curved printing plate made up of a plastic facing and a metal backing.

COMPOSITE SHEET. G. J. Alles (to Sylvania Industrial Corp.). U. S. 2,356,023, August 15. An elastic sheet material consisting of a plastic sheet having pyramid-like depressions and elevations combined with a network of elastic bands attached to the sheet.

LACQUERS. C. E. Bergamini (to Hercules Powder Co.). U. S. 2,356,025, August 15. A lacquer emulsion of an ethyl cellulose lacquer and the reaction product of a hydrogenated rosin with a volatile alkali.

INJECTION MOLD. E. E. Novotny (to Durite Plastics, Inc.). U. S. 2,356,081, August 15. A device for injection molding thermosetting material.

COPOLYMERS. M. J. Roedel (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,356,091, August 15. A copolymer obtained by emulsion copolymerization of methacrylic acid and a sulfur modified 2-halo, 1-3-butadiene polymer or a vinyl interpolymer thereof.

OLEFINIC COPOLYMERS. R. M. Thomas and W. J. Sparks (to Jasco Inc.) U. S. 2,356,128–9–30, August 22. Solid plastic interpolymers are prepared by reacting an aliphatic isoolefin having 4 to 7 carbon atoms with a conjugated aliphatic diolefin, or a normal diolefin at a temperature between 0 and –160°C. in presence of Friedel-Crafts catalyst.

FLOOR. J. J. Widmayer. U. S. 2,356,138, August 22. A plastic floor, comprising fibrous blocks, spaced to provide plastic receiving channels therebetween.

ION EXCHANGE RESIN. J. W. Eastes (to Resinous Products and Chemical Co.) U. S. 2,356,151, August 22. A resin capable of removing acidic constituents from liquids, comprising the condensation product of a polyphenylol alkane, an alkylene polyamine and formaldehyde.

CELLULOSE ESTERS. H. Dreyfus (to Celanese Corp. of America). U. S. 2,356,228, August 22. Lower fatty acid esters of cellulose are prepared by esterifying cellulose with the acid anhydride in a chlorinated lower aliphatic compound which is a solvent for the primary ester.

ADHESIVE. E. H. Land (to Polaroid Corp.). U. S. 2,356,250, August 22. A laminated article comprising a rigid transparent sheet and a cellulose acetate sheet cemented together by a thin film of a mixture of incompletely polymerized polyvinyl acetal and glycerol triricinoleate.

LIGHT POLARIZING MATERIAL. E. H. Land (to Polaroid Corp.). U. S. 2,356,251, August 22. A light polarizing material is prepared by mixing a solution of birefringent crystals with a solution of a plasticized transparent plastic, evaporating the solvents, hardening the plastic and finally orienting the crystals within plastic by an external force.

LAMINATE. E. H. Land (to Polaroid Corp.). U. S. 2,356,252, August 22. A shatterproof laminate comprising a rigid support, a polarizing film, a barrier film and a heavy adhesive layer, all layers being permanently bonded.

CELLULOSE ACETATE. G. Schneider (to Celanese Corp. of America). U. S. 2,356,277, August 22. Cellulose acetate is precipitated from acetic acid solution by water which is added from the bottom of the reaction vessel and withdrawn from the top until all acid is removed, partially draining, stabilizing, adding a solution of a mild alkali and again washing until neutral.

STABILIZING POLYVINYL ALCOHOL. G. S. Stamatoff (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,356,282, August 22. Polyvinyl alcohol is stabilized by treating in a bath of a monohydric alcohol, water and a weak acid salt of sodium or potassium hydroxide.

ADHESIVE TAPE. E. A. Rodman (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,356,354, August 22. Waterproof adhesive tape is prepared by mixing cellulose acetate with a plasticizer and subjecting the mass to kneading action, adding pigment, adding oleic acid, heating on calender rolls, calendering to a thin sheet and finally applying a rubber pressure-sensitive adhesive to the film.

MOLD PARTS. R. G. Chollar (to National Cash Register Co.). U. S. 2,356,380, August 22. Mold parts originally made of metal are replaced with parts of molded thermosetting resin.

RESIN. E. L. Cline (to Allied Chemical and Dye Corp.). U. S. 2,356,384, August 22. A resin prepared by heating an indene-styrene homolog fraction of resin oil in the presence of a clay catalyst.

WASHING APPARATUS. H. A. Kuntz (to Libbey-Owens-Ford Glass Co.). U. S. 2,356,411, August 22. An apparatus for washing flexible plastic sheets.

WATER SOLUBLE RESINS. J. G. McNally and F. C. Duennebier (to Eastman Kodak Co.). U. S. 2,356,466, August 22. A water soluble resin is obtained by heating a phenol with the reaction product of a sulfonated phenol, urea and formaldehyde.

VINYL RESINS. D. R. Swan (to Eastman Kodak Co.). U. S. 2,356,479–80, August 22. A polyvinyl acetal resin in which some of the acetal groups are alkoxy acetaldehyde, and polyvinyl acetal resin containing hydroxyl groups, ester groups, acetaldehyde acetal groups, and branched chain saturated aldehyde acetal groups.

RESINS. S. G. Trepp (to United Gas Improvement Co.). U. S. 2,356,494, August 22. Cyclopentadiene or its alkyl derivatives are polymerized in the presence of boron trifluoride.

POLYAMIDES. M. Hagedorn (to Alien Property Custodian). U. S. 2,356,516, August 22. Hydrophilic polyamides

are prepared by polymerizing the hydrohalide of an omega monoamino monocarboxylic acid with a similar acid hydrohalide.

SYNTHETIC RESINS. H. Berg and H. Mader (to Alien Property Custodian). U. S. 2,356,562, August 22. Vinyl chloride is purified in the vapor phase by treating with a solution of an alkali metal hydroxide, thus enabling formation of high molecular weight polymers when subjected to polymerization reactions.

VINYL POLYMER. W. Hentrich and R. Endres (to Alien Property Custodian). U. S. 2,356,586, August 22. Polyvinyl chloride is plasticized with a monobasic aliphatic carboxylic acid ester of thio-diglycol.

POLYAMIDES. P. Schlack (to Alien Property Custodian). U. S. 2,356,702, August 22. High molecular linear polyamides are prepared by condensing with splitting off of phenol and carbon dioxide, the dicarboxylic acid obtained by saponification of reaction product of glutaric acid dichloride with *N*-methyl aminocaproic acid ethylester hydrochloride.

ION EXCHANGE RESINS. H. P. Wohnsiedler and W. M. Thomas (to American Cyanamid Co.). U. S. 2,356,719, August 22. Cationic resins comprising an aqueous solution of partially polymerized guanamine - formaldehyde or ammeline - formaldehyde.

RESIN. R. Kern (to Alien Property Custodian). U. S. 2,356,764, August 29. A film-forming condensate of butane-diol-1,4 di-normal poryl ether omega-omega prime diamine and carbon disulphide.

POLYMERS. E. L. Kropa (to American Cyanamid Co.). U. S. 2,356,767, August 29. A process which comprises polymerizing branched chain vinyl keto amines in the presence of a zinc salt.

VARNISH. M. Holzmer and T. A. Neuhaus (to Glidden Co.). U. S. 2,356,789, August 29. A varnish consisting of a solution of an unmodified heat-hardenable phenol-formaldehyde resin and a methyl or ethyl abietate.

RESIN EMULSION. A. E. Peiker (to American Cyanamid Co.). U. S. 2,356,794, August 29. A cloth printing emulsion consisting of a solution of an alkyd resin, a urea-formaldehyde resin and a cellulose ether.

MOLDING. H. G. Bimmerman and A. L. Fox (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,356,814, August 29. Thermoplastic molding is facilitated by coating mold surfaces with a solution of an alkane sulfonic acid and a chloralkane sulfonic acid.

COPOLYMERS. E. W. Moffett and R. E. Smith (to Pittsburgh Plate Glass Co.). U. S. 2,356,871, August 29. The copolymerizate of a mixture of vinyl chloride and allyl chloride or a related derivative.

COATING. W. Pense, W. Asch, P. May and H. Stark (to Alien Property Custodian). U. S. 2,356,879, August 29. A lustrous coating for fibrous materials consisting of a salt of the free acid from the interpolymerizate of maleic anhydride and vinyl butyl ether.

FILAMENTS. J. J. Reis, Jr. (to Pittsburgh Plate Glass Co.). U. S. 2,356,886, August 29. A method for preparing filaments from a solution of an organic plastic.

MOLDING POWDER. R. E. Smith (to Pittsburgh Plate Glass Co.). U. S. 2,356,896, August 29. A molding powder is prepared by dissolving a thermoplastic resin in a solvent, adding a non-solvent diluent which causes incipient gelation, chilling to a gel, agitating during syneresis to liberate solvent, thus forming a finely divided dispersion, further diluting while still chilled to provide a non-agglomerating dispersion, and finally removing the mixture of solvent to form a dry powder.

MOLDING PROCESS. Z. T. Walter. U. S. 2,356,902, August 29. A mold having a reversely curved surface adapted to form a curved plastic article to be cured thereon, a fabric strip impregnated with a plastic solution which binds the strip to the surface with an adhesive force greater than the contracting force exerted by curing.

VINYL HALIDES. C. F. Fryling (to B. F. Goodrich Co.). U. S. 2,356,925, August 29. A vinyl halide or a mixture of a vinyl halide with a vinyl ester, is polymerized in the presence of a water soluble compound of sulfur and oxygen and a complex iron salt.

COVERING. E. G. Reed (to Wingfoot Corp.). U. S. 2,356,948, August 29. Method of covering furniture with a woven fabric of stretched rubber hydrochloride by fastening the edges and finally applying heat to the fabric to cause it to shrink and fit the surface.

RESIN. R. M. Thomas and W. J. Sparks (to Jasco, Inc.). U. S. 2,356,955, August 29. A clear colorless polyisobutylene containing sulfur as stabilizer.

ABRASIVE. H. V. Allison (to Allison Co.). U. S. 2,356,965, August 29. An abrasive article is prepared by mixing styrene with styrene-butadiene copolymer, adding a curing agent and abrasive grains, and finally curing.

RUBBER HYDROCHLORIDE. A. M. Clifford (to Wingfoot Corp.). U. S. 2,356,973, August 29. Rubber hydrochloride containing a minor proportion of an *N, N'*-dialiphatic piperazine.

DIENE INTERPOLYMERS. A. M. Clifford (to Wingfoot Corp.). U. S. 2,356,974, August 29. The copolymerizates of aliphatic conjugated diene hydrocarbons and aromatic compounds containing ether groups and polymerizable olefinic side chains.

LIGNIN RESIN. G. F. D'Alelio (to General Electric Co.). U. S. 2,357,090, August 29. A dispersion of a reactive resinous composition is prepared by dissolving a phenolic solution of lignin, reacting with formaldehyde in presence of an acid catalyst, refluxing, alkalizing, reacting with additional formaldehyde, adding a dispersing agent, neutralizing and finally adding sufficient dispersing agent to form a stable dispersion.

PITCH RESIN. G. F. D'Alelio (to General Electric Co.). U. S. 2,357,091, August 29. A reactive composition is prepared by dissolving pine wood pitch in a phenol, reacting with formaldehyde in presence of an acid catalyst, refluxing, alkalizing, refluxing with additional formaldehyde, adding a dispersing agent, neutralizing and finally adding sufficient dispersing agent to form a stable dispersion.

SUPERPOLYAMIDES. M. Hagedorn (to Alien Property Custodian). U. S. 2,357,187, August 29. Hydrophilic synthetic linear polyamides are prepared by heating hexamethylenediamine sebacate with glycocol ethylester hydrochloride.

PLASTICIZER. C. Opp (to Interchemical Corp.). U. S. 2,357,221, August 29. The reaction product of sebacic acid, succinic anhydride, ethylene glycol, and glycerol is used as a plasticizer for cellulose derivatives.

ABRASIVE. J. H. Kugler and B. J. Oakes (to Minnesota Mining and Mfg. Co.). U. S. 2,357,335, September 5. Abrasive sheet consisting of a backing sheet, an impregnating coat of adhesive material comprising a non-oxidizable thermoplastic synthetic resin such as a polyvinyl acetal, substituted butadiene polymer, and a final coat of resinous material containing abrasive particles.

ABRASIVE. G. P. Netherly, B. S. Cross, and G. R. Anderson (to Minnesota Mining and Mfg. Co.). U. S. 2,357,348, September 5. An abrasive article comprising abrasive grains bonded with a polymerized mono-hydric alcohol ester of alkyl substituted acrylic acid.

# American Chemical Society meeting*

POLYMERIZATION OF VINYL DERIVATIVES IN SUSPENSION. W. P. Hohenstein, F. Vingiello and H. Mark, Polytechnic Institute of Brooklyn.

If one disperses an unsaturated organic compound, such as isoprene, styrene, acrylic ester or vinyl acetate in water, and adds a catalyst of the peroxide type, polymerization takes place in suspension. The rate of this reaction and the polymerization degree of the produced material depend upon the following conditions: 1) The average size of the globular particles. The size can be varied between fractions of a millimeter and several centimeters, and remains constant throughout the course of the reaction. 2) The concentration and nature of the initiating catalyst. It is possible to start polymerization both with water-soluble and monomer-soluble catalysts, such as sodium perborate and benzoyl peroxide. 3) The temperature of the system, which is usually maintained between 0 and 75° C. and influences both rate and degree of polymerization.

From the study of the various conditions as listed above, it appears that polymerization in suspension can be considered to be essentially a water-cooled block polymerization, offering the advantage of an easily controlled temperature distribution and of no contamination of the polymer with emulsifying agents.

STRUCTURE OF COPOLYMERS. T. Wall, University of Illinois.

Using the chain growth concepts of Norrish and Brookman, there is developed a general theory of copolymerization involving relative polymerization velocities as functions of monomer composition. Assuming that two kinds of monomers, $X$ and $Y$, are involved, the growing polymer chains are characterized by the last added monomer unit. Accordingly, four possible chain growth steps are recognized, namely: $X$ to $X$, $X$ to $Y$, $Y$ to $X$, and $Y$ to $Y$. The relative polymerization velocities plotted against composition give diagrams which assume different forms depending upon the values assigned to the four specific reaction rate constants. The treatment is developed in analogy to vapor pressures of binary systems. Nonideal copolymerizations can sometimes lead to "azeotropic copolymers," which are homogenous copolymers derived from constant polymerizing mixtures. The nature of such "azeotropes" together with their intramolecular distributions are considered. The behavior of certain polymerization systems, particularly those leading to so-called heteropolymers, is accounted for by the theory.

INFLUENCE OF SIDE GROUPS ON STRUCTURE OF LINEAR POLYMERS. W. O. Baker and C. S. Fuller, Bell Telephone Laboratories, Inc.

Basic structural principles may be derived when vinyl polymers and condensation polymers are regarded as derivatives of *n*-paraffin chains such as polyethylene. The simplest chain packing of the extended, planar zig-zag paraffins is then progressively altered as other groups are introduced virtually within the chains (polyesters, polyethers, polyamides, etc.) or as side groups on it (vinyl polymers, N-$CH_3$ polyamides, etc.). Ordering of the main chains may be expected when the side groups are: 1) especially numerous, 2) versatile in packing, and 3) small but strongly interacting, as in polyvinyl alcohol and polyacrylonitrile. Higher than liquid order within x-ray dimensions, appears when these side groups are large and specific in packing, such as in polyvinylcarbazole when contrasted to polystyrene.

SOLUBILITY AND SOLUTION VISCOSITY OF POLYVINYL ETHERS. C. E. Schildknecht, W. E. Hanford and D. E. Stokes, General Aniline & Film Corp.

Polymers of alkyl vinyl ethers are a relatively new class of plastic materials which comprise from viscous liquid to relatively nontacky rubberlike solids depending upon the particular alkyl group and upon the polymer chain length. High polymers of *n*-butyl vinyl ether are of special interest in possessing, along with rubberlike elasticity and tack, complete solubility in an unusually wide variety of organic solvents. Viscosities have been determined for a single *n*-butyl vinyl ether polymer in more than 30 pure solvents including aliphatic and aromatic hydrocarbons, alcohols, ethers, esters, ketones and chlorinated solvents. Wide differences in viscosity have been found which have been related to the structure and dipole characteristics of the solvents.

STUDIES OF VAPOR PERMEABILITY OF SELF-SUPPORTING FILMS. W. H. Aiken, P. M. Doty and H. Mark, Polytechnic Institute, Brooklyn.

A vacuum cell is described which measures the diffusion of vapors through thin films within a range of up to about 50-mm pressure gradient. The temperature can be varied up to about 70° C. Measurements have been carried out with films of saran, Pliolite, polythene, Butacite, Koroseal, Vinylite, nylon, cellulose esters, cellophane and polyvinyl alcohol. The amount of vapor which passes through the film has been measured as a function of time, pressure gradient, film thickness and temperature. The results are interpreted on the basis of the theory of diffusion as previously applied by other investigators. According to this concept, the permeability of films depends upon the rate of diffusion of the vapor through the film and upon the solubility of the diffusing material in the high polymer of which the film is formed. The results are discussed in terms of the molecular structure of the investigated materials.

POLYMERIZABLE ESTERS OF LACTIC ACID. ALPHA-CARBALKOXYETHYL ACRYLATES AND METHACRYLATES. C. E. Rehberg, Marion B. Dixon and C. H. Fisher, Eastern Regional Research Laboratory.

Alpha-carbalkoxyethyl acrylates and methacrylates were prepared by acylating methyl, ethyl, isopropyl, *n*-butyl, isobutyl, cyclohexyl, allyl, methallyl and methyl vinyl carbinyl lactates with acrylyl chloride methacrylyl chloride or methacrylic anhydride. The resulting esters polymerized readily, yielding colorless, transparent resins.

The acrylates and methacrylates prepared from alkyl lactates which contained only one olefinic linkage, yielded thermoplastic polymers that were roughly similar in hardness and appearance to the corresponding polyalkyl acrylates and methacrylates. The brittle temperatures of the polymers roughly paralleled the hardness. The hardest and softest polymers, respectively, were obtained from the methacrylate of methyl lactate and the acrylate of *n*-butyl lactate.

When polymerized, the acrylates and methacrylates prepared from allyl, methallyl or methyl vinyl carbinyl lactate yielded insoluble and infusible resins (presumably cross-linked). When the esters containing two olefinic linkages were copolymerized with methyl acrylate in ethyl acetate solution, only a small proportion (approximately 0.2 percent of the monomer mixture) of the bifunctional monomers was needed to cause gelation. Earlier experiments showed that even smaller proportions of some monomers (methallyl or betachloroallyl acrylate) are effective in producing gels,

*The abstracts presented on these pages are of papers on plastics presented at the American Chemical Society meeting held in New York, Sept. 11-15, 1944.

whereas larger quantities of furfuryl, citronellyl or crotyl acrylate are required.

RESINOUS PLASTICIZERS DERIVED FROM SEBACIC ACID. K. K. Fligor and J. K. Sumner, Resinous Products and Chemical Co.

New resinous plasticizers derived from sebacic acid have been found to impart certain unique and valuable properties to synthetic elastomers, particularly polyvinyl chloride-acetate copolymer and butadiene-acrylonitrile rubbers. These materials, a logical development of the familiar sebacic acid alkyd resins used as plasticizers for cellulose nitrate and ethyl cellulose, and of dibutyl sebacate and dibenzyl sebacate (employed in acrylonitrile and chloroprene rubbers, as well as in vinyl elastomers), are polyesters which impart properties hitherto unobtainable with the simple esters, amides, ethers, etc. It is proposed to distinguish the resinous-type plasticizers by the term "polymeric plasticizers" as against the simpler, commonly used materials designated as "monomeric plasticizers" in view of the characteristics of each class.

The new sebacic acid polyester plasticizers are characterized by outstanding permanence, oil, solvent and gasoline resistance, water resistance, heat stability and low flammability. These properties, combined with a wide range of compatibility and good plasticizing action, have fostered the application of the polymeric plasticizers under conditions of extreme service requirements. A broad study has been made of the properties of a polyvinyl chloride-acetate copolymer and an acrylonitrile rubber which contained one of the most promising of the polyester plasticizers. A survey has been made of properties of other synthetic rubber stocks, polyvinyl chloride and cellulose ethers and esters plasticized with a polyester.

EMULSION POLYMERIZATION OF ACRYLIC ESTERS. W. C. Mast, Lee T. Smith and C. H. Fisher, Eastern Regional Research Laboratory.

Effects of various agents on the emulsion polymerization of acrylic esters are described, and directions are given for preparing several types of resin emulsions. When emulsion polymerization is used merely to convert monomeric acrylic esters into polymers or copolymers of relatively high molecular weight, Tergitol penetrant No. 4 and ammonium persulfate can be used satisfactorily as emulsifier and polymerization catalyst, respectively. The resulting emulsion is only moderately stable and can be coagulated readily by the addition of aqueous solutions of sodium chloride, acetic acid, or mixtures of the two. Triton K60 and hydrogen peroxide also can be used conveniently to produce emulsions of only moderate stability.

Emulsions remarkably stable to electrolytes (but not to mechanical agitation or solvents such as acetone and ethanol) can be made with Triton 720 as the emulsifier. Triton 720 and Tergitol penetrant No. 4 can be used together in various proportions to produce emulsions of almost any desired stability to electrolytes. Stable emulsions suitable for brushing and spraying can be prepared with several combinations of agents. The combination used frequently for this purpose is E. F. Houghton No. 1, ammonium alginate, ammonium hydroxide and ammonium persulfate. The viscosity of acrylic resin emulsions can be controlled over a wide range by using various quantities of ammonium alginate, modified casein and Tergitol penetrant No. 4. Films obtained from these emulsions adhere well to smooth surfaces.

CELLULOSE COMPOUNDS IN THERMOPLASTIC LAMINATES. C. W. Eurenius, R. H. Hecht, Wm. Koch, H. C. Malpass, Hercules Powder Co.

Thermoplastic laminates made with ethyl cellulose and cellulose acetate have outstanding toughness, can be heated and drawn into complex shapes with inexpensive equipment, and have the definite advantage of quick and easy fabrication. Individual parts may be joined together by heat or solvent sealing. By the proper selection of plastic, such qualities as low-temperature flexibility, low or high modulus, and excellent dielectrical properties are attainable. All the pressure combinations have better tear resistance than the plastics from which they are made, and the range of color is unlimited. Solvent laminates have exceptional impact strength and low density but are inferior to the pressure type in so far as tensile and flexural properties are concerned. Their advantage lies in the fact that they lend themselves to easy fabrication of large and complex shapes by simple lay-up over inexpensive molds.

TEMPERATURE EFFECT ON STRENGTH OF LAMINATES. Patrick Norelli and W. H. Gard, Westinghouse Elec. & Mfg. Co.

The proper use of plastic laminates requires a knowledge of their physical properties over the range of temperatures through which the product might be employed. This paper deals with this problem relative to the specialized field of phenolic laminates and reports their tensile, compressive and shear characteristics from −55 to 200° C. The elevated temperatures were attained by means of a small cylindrical furnace constructed to employ electrical-resistance heating. To reach subnormal temperatures a bath of solid carbon dioxide and alcohol was employed in a cylindrical vessel of annular construction. The yield strength, ultimate strength and modulus of elasticity in tension, the ultimate strength in compression and the ultimate strength in shear are reported at −55, −20, 0, 25, 75, 150, and 200° C.

We may conclude from the results of these tests that the tensile, compressive and shear strengths of phenolic laminates are inversely proportional to temperature, and that the cellulose-filled materials are more sensitive to temperature change than their mineral-filled counterparts. The rate of loss of strength as a function of temperature increases above room temperature for the cellulose-filled laminates, whereas it decreases for the mineral-filled materials. Evidence of this variable change is supported by thermal expansion data for a typical laminate. The thermal expansion curve is shown to have a transition point occurring at a temperature well within the range at which the accelerated change in physical properties seems to take place.

SOME PHYSICAL AND CHEMICAL PROPERTIES OF POLYTHENE. F. C. Hahn, M. L. Macht and D. A. Fletcher, E. I du Pont de Nemours & Co., Inc.

This unique hydrocarbon resin, polythene, has recently become available commercially from domestic sources. The low electrical losses along with high resistance to moisture and chemicals, and toughness over a wide range of temperatures have led to wide usage, particularly in the electrical field, and they indicate many other potential applications for this new product. The unusual resistance of this material to various types of chemicals suggests many other fields for its use. Data on the chemical resistance of this product, showing the effects of exposure to various chemicals on the physical properties, are presented and discussed. These point to many possible applications, such as in special types of equipment, containers, gaskets, tubing, etc. As a means of protecting metal surfaces from corrosion and applying polythene coatings in general, the process of flame spraying the powdered material is described. Certain flame-sprayed compositions show excellent adhesion to metals and give excellent protection against corrosion by water, brine, etc. These data are presented together with a discussion of this method of plastics application. Data on other physical properties of polythene are presented.

EFFECT OF ULTRAVIOLET LIGHT ON CELLULOSE ACETATE AND CELLULOSE NITRATE. T. S. Lawton and H. K. Nason, Monsanto Chemical Co.

The effect of ultraviolet light on the viscosity of cellulose acetate and cellu-

lose nitrate has been studied in atmospheres of air, nitrogen and oxygen. The degradation which took place was measured by dilute solution viscosity. Both continuous and intermittent exposure under the three different atmospheres were studied. In the absence of heat and light, both cellulose acetate and cellulose nitrate show practically no change in viscosity up to 200 hr. exposure. In an air atmosphere, exposure of cellulose acetate and cellulose nitrate to ultraviolet light causes the viscosity to decrease with time. The effect of a nitrogen atmosphere is to retard this degradation, whereas oxygen accelerates it. For both materials, intermittent exposure first to nitrogen and then to oxygen has the effect of retarding and then accelerating the degradation. In all atmospheres, the drop in viscosity for cellulose acetate was gradual whereas, for cellulose nitrate, the viscosity dropped more rapidly during the initial part of exposure and then leveled off. The practical importance of these effects, with respect to commercial plastics based on cellulose acetate or nitrate, is discussed.

LIGNOCELLULOSIC RESIDUES —A SAGA OF WASTE. Robert S. Aries, Northeastern Wood Utilization Council, Yale University.

The amount and types of lignocellulosic wastes from forest and agricultural sources are examined in the light of present industrial uses and potential requirements. Chemical conversion is the best answer to the problem, as many of the wastes are just as satisfactory as the high-grade materials which can be used for other purposes.

Figures are given on the amount of and kind of non-utilized wood in the mechanical industries, and such chemical industries as pulping, distillation, hydrolysis for alcohol, hydrolysis for plastics and fillers, tannin and dye extraction, etc. Statistics are given on the quantities and industrial uses of farm by-products, and surpluses and their potentialities are reviewed from the technico-economic point of view. The relative merits of forest and agricultural wastes are evaluated, pointing out that wood residues are much more promising in future utility.

Some novel applications of lignin are reviewed with special emphasis upon outlets permitting potential large-scale utilization. Factors such as possible markets, transportation costs, and quality of the material available are examined. The technical and economic conditions affecting the manufacture and sale of chemicals derived from lignocellulosic wastes are translated into the national scale and conclusions drawn from the point of view of competition from other materials as well as the depletion of some nonrenewable resources.

EFFECT OF SYNTHETIC RESINS ON THE PHYSICAL AND CHEMICAL PROPERTIES OF CELLULOSE AND PROTEIN FIBERS. D. H. Powers, Monsanto Chemical Co.

When cellulose fibers are impregnated with resin-forming solutions of unpolymerized urea-formaldehyde, melamine-formaldehyde or phenol-formaldehyde, these resin formers have little effect on the properties of the fibers until they are cured or polymerized within the fiber. Evidence shows that the resin is uniformly distributed through the fiber and in certain cases may actually react within the cellulose. Low concentrations of the resins formed within the fiber have pronounced effects on the physical properties, changing the elongation, elasticity, wet strength, moisture regain, resilience and dyeing properties. A new method of determining the degree of resin polymerization has been developed.

It is also shown that wool and protein fibers may be impregnated with resin-forming solutions; however, there is no evidence that they react with the wool protein. The medium in which the resin-forming materials are applied has a tremendous effect on the properties obtained, and it is shown that fiber swelling is necessary to ensure thorough penetration of the solution.

CHARACTERIZATION OF CELLULOSE DERIVATIVES BY SOLUTION PROPERTIES. H. M. Spurlin, A. F. Martin and H. G. Tennent, Hercules Powder Co.

Nearly all thermoplastic materials are used in the form of concentrated solutions of polymer in plasticizer. The plasticizer does not differ in the essential features of its behavior from other solvents. It is shown by examples that the commercially useful cellulose-derivative plastics lie in a relatively narrow range of the system solvent-polymer, which system follows quite closely the equations found empirically by Flory and given theoretical background by Eyring. The problem of formulation of plastics is to fit one rigidly defined set of conditions at molding temperature and another set at use temperature. The temperature coefficient of each of the types and intersections present in a polymer-solvent system is thus very important.

It appears that a study of more dilute solutions of the polymer in the plasticizer will give quantitative data of use in understanding the behavior of plastics. The viscosity-concentration curves determined over a range of temperatures should give much information about interactions between polymer chains in the presence of various types of plasticizers. It should also be necessary to determine the miscibility of the fractions of the polymer with the plasticizer as a function of temperature in order to understand both the molding process and the physical properties at room temperature.

MECHANICAL PROPERTIES OF CELLULOSE ACETATE AS RELATED TO MOLECULAR CHAIN LENGTH. Arnold M. Sookne and Milton Harris, National Bureau of Standards.

The preparation and mechanical properties of a series of cellulose acetate fractions and blends were described earlier. The number-average degrees of polymerization (DP's) of the fractions in acetone solutions have now been estimated in acetone solutions. The number-average DP's are directly proportional to the intrinsic viscosities.

The tensile strengths, ultimate elongations and folding endurances of films prepared from the fractions and blends were plotted against their number-average and weight-average DP's. When the mechanical properties are plotted against the weight-average DP's, the results for the fractions and different blends fall on separate curves. In contrast, when the mechanical properties are plotted against the number-average DP's, the results for the fractions and all of the blends fall on a single curve for each property. These results are shown to be qualitatively consistent with the hypothesis that the mechanical properties of blends are the sums of the mechanical properties of their components. The results emphasize the practical importance of determinations of the number-average DP in studying commercial polymolecular materials.

INTER-CHAIN ORDER AND ORIENTATION IN CELLULOSE ESTERS. W. O. Baker, Bell Telephone Laboratories, Inc.

A continuous series of states of short-range molecular order from amorphous to crystal-like has previously been shown to result from appropriate heat treatment, solvent action, etc., in solid cellulose esters and other linear polymers. The order-disorder proportion strongly influences physical properties of the solids, and is affected by rate of cooling during molding, by subsequent aging, etc. These studies, aimed at describing by means of the fine structure the principal mechanical behavior of thermo-plastic cellulose derivatives, have been extended to various oriented states of cellulose esters and mixed esters. These include orientation (Sisson's classification) found in fibers (uniaxial), parts of injection moldings (imperfect uniplanar, uniaxial and biaxial), and rolled sheets (uniplanar or selective uniaxial, i.e., biaxial). X-ray

diffraction was principally used to indicate structure and orientation.

### THE PREPARATION, PROPERTIES AND USES OF PAPER-BASE LAMINATES. T. A. Howells and H. F. Lewis, The Institute of Paper Chemistry.

The production of a sheet of paper such as yields high-strength laminates is believed to result from a combination of conditions in both pulping and papermaking, and many of the important variables in these operations have not yet been fully identified. The wood used defines fiber dimensions and chemical components of the pulp. Pulping and purification processes affect the chemical composition, strength of fibers, and nature of fiber surfaces, and papermaking conditions control the physical structure of the web of paper which affects fiber-to-fiber and fiber-to-resin contacts, physical condition of the fiber elements, and the path followed by the resin during impregnation.

The types of resin are important as they relate to the characteristics of the end product. The principal drawback of the phenolics and furanes is their relatively low edgewise impact; the thermoplastics, on the other hand, have relatively low tensile strengths and high water absorption. The reason for this difference in behavior will be discussed. Improvement in the impact strength of the phenolic resin laminates may be obtained through the use of combinations of paper with wood veneer and with cloth.

### BASIC PHENOMENA ASSOCIATED WITH IMPACT TESTING AND THEIR RELATION TO STRUCTURE AND COMPOSITION OF PLASTICS. D. R. Morey, Eastman Kodak Co.

Mathematical models for explaining the observed mechanical behavior of elasto-plastic bodies make use of viscous mechanisms with various relaxation times. A discussion of such models is given, together with the various types of bonding which have different relaxation times. As the rate of deformation increases from that in long-time experiments to that in impact testing, the various types of bonds change their relative contribution to the mechanical behavior. Temperature plays an important part and may be used to study more conveniently the short relaxation times. At the very high deformation rates, the mechanical behavior is also affected by the presence of a shock wave travelling with the speed of sound in the material. This phenomenon brings in the dimensions of the test piece and reflections from clamps. An important consideration is steepness of wave front and how it is smoothed out by submicroscopic inhomogeneities.

### EFFECT OF THE PREPARATION OF THE SPECIMENS ON THE PHYSICAL PROPERTIES OF CELLULOSIC MOLDING COMPOUNDS. R. H. Ball, C. E. Leyes and A. Melnychuk, Celanese Corp of America.

Cellulose acetate, cellulose acetate butyrate and ethyl cellulose molding materials are transformed into finished articles principally by the injection molding process. It is, therefore, proper that injection-molded test specimens should be used in evaluating the physical properties of these materials. In the use of injected specimens, because of the number of variables involved in this molding method, it was necessary to learn which of these variables affect the physical properties. This problem has been studied on a 1-oz. laboratory injection machine, equipped with accurate controls, using tensile and impact bars as the specimens. The factors studied include main heater temperature, secondary heater (preheater) temperature, mold temperature, molding cycle, and orifice diameter of nozzle tip.

Main heater temperature was found to be the most important factor affecting impact and tensile properties. Between the minimum temperature required to fill the mold and maximum molding temperature, which covers a temperature span of 50 to 125° F., impact figures on a particular compound have been found to vary as much as 275 percent, tensile strengths as much 127 percent, and elongation values as much as 113 percent. This applies to all compounds studied in cellulose acetate, cellulose acetate butyrate and ethyl cellulose. The largest spread in impact and tensile strength values occurs in cellulose acetate butyrate.

The orifice diameter of the nozzle tip was also found to have a large influence on physical properties. Variations in secondary heater temperature, mold temperature and molding cycle did not produce important changes in physical properties. This study shows that impact, tensile and elongation values determined on injection-molded specimens have little value unless the molding conditions are standardized between various laboratories.

### HIGH-SPEED IMPACT TESTING OF PLASTICS. E. L. Kropscott and Paul H. Lipke, The Dow Chemical Co.

In many applications the satisfactory performance of a plastic material depends upon its ability to withstand sudden shock. The behavior of plastics when exposed to these high-speed impacts cannot be predicted by conventional low-speed tests. Costly and time-consuming performance tests are now required on every molded part. The strength and behavior of a plastic can be studied, by means of laboratory tests, at any given velocity of impact. Each plastic has a critical velocity where it changes from a tough to a brittle material. Factors which influence high-speed impact strength include temperature, shape and flexibility of the sample, velocity, and energy at the point of impact. The impact strengths of a number of commercial plastics have been measured at various velocity levels up to 2000 ft. per second. Cellulose derivative plastics are shown to have a wider range of toughness than the vinyl resins and urea-formaldehyde plastics. The effect of plasticizers, temperature, humidity and molding conditions on ethyl cellulose plastics is also discussed.

### WEATHER RESISTANCE OF CELLULOSE ESTER PLASTICS. L. W. A. Meyer and W. M. Gearhart, Tennessee Eastman Corp.

A comparison of the resistance of several cellulose ester compositions to outdoor weathering is presented. Compositions tested include cellulose acetate butyrate and cellulose acetate as base materials with dibutyl sebacate, triphenyl phosphate and diethyl phthalate as plasticizers, and phenyl salicylate as ultraviolet inhibitor. Effects of exposure at Phoenix, Ariz., Fort Myers Beach, Fla. and Kingsport, Tenn., are given. Physical properties considered are appearance, elongation, tensile strength, flexural strength, flow temperature and intrinsic viscosity. Effects of exposure on properties of the plastics are correlated with climatic conditions. Test results indicate that these compositions are subject to considerable degradation on outdoor weathering and that this effect becomes less pronounced under more temperate climatic conditions. The resistance to weathering can be somewhat improved by the proper choice of plasticizer; it can be very materially improved by adding small proportions of an ultraviolet light inhibitor such as phenyl salicylate. The addition of an inhibitor is effective for both cellulose acetate butyrate and cellulose acetate compounds but more effective for the former.

### A PRECISE METHOD FOR THE ISOLATION OF HIGH POLYMERS. F. M. Lewis and F. R. Mayo, United States Rubber Co.

The adequacy of polymer isolation methods is discussed. Methods commonly used in which monomer or solvent are distilled from the polymer in vacuo may require several days for the polymer to attain constant weight and may yield an inhomogeneous product. A method is described whereby a reprecipitated polymer is dissolved in benzene, the whole frozen in dry ice, and the majority of benzene sublimed off at 0°C. in vacuo, after which the polymer is heated in vacuo at 60-100° for 8 to 24 hr. to remove the last traces of solvent. This process leaves a fine, porous polymer, easily broken up and manipulated and completely homogeneous.

# BOOKS AND BOOKLETS

**Write directly to the publishers for these booklets. Unless otherwise specified, they will be mailed without charge to executives who request them on business stationery. Other books will be sent post-paid at the publishers' advertised prices.**

### Plastics in the World of Tomorrow

**by Captain Burr W. Leyson**

**Published by E. P. Dutton and Co., Inc., New York, 1944**

**Price $2.50 184 pages**

An Army officer once admitted at a plastics conference that he was an "expert" on the subject by decree. However, it still takes more than a publisher's commission to create an "authentic" book on any topic.

Captain Leyson has taken the "History of Plastics" published in 1940 in Modern Plastics as the basic outline for his treatment of the plastic materials and their fabrication and has illustrated his book copiously with photographs supplied by this magazine. At that point fancy and fiction take over, possibly because the author believes that in the promotion of plastics "technical education is not so important," in fact "too much of it may be disadvantageous."

This can be the only explanation of such weird statements as the following: "All of our modern canned foods are packed in cans which have their interiors protected by a plastic . . . usually of the vinyl-resin type." "The use of this plastic-bonding method (Cyclewelding) has effected startling changes in our production of aircraft for the war." Referring to esterification, "the result of such a chemical reaction is the formation of a plastic." Regarding lignin plastics, "later developments brought them in use for furniture." Discussing aircraft uses, "at the present time the most important use of plastics is the structural, where it is used as a bonding agent in plywood."

Doubtless Captain Leyson's book, written in the dashing narrative style used very successfully in his previous books on aircraft, automobiles, fire control, photography and mechanics, will interest and stimulate the imagination of his readers who are unfamiliar with plastics. This could have been accomplished, however, without such gross misstatements and exaggerations as those illustrated above.

Minor factual and typographical errors also detract from the rating of the book, such as "methyl-crylate," discovery of "pyroxlyin" plastic in "1896," and "benzine" for "benzene." Only 8 of the 52 application photographs identify the material used by generic or trade name, the remainder carrying the loose designation "plastic," which is not highly informative in a "comprehensive general survey designed to present the various plastics to the reader." In other words of the author, "everyone is talking about plastics but few know what they are."

Needless to say, the "expert assistance" given the author by Modern Plastics did not include a review of the manuscript. G.M.K.

### British Plastics Year Book 1944

**Published by Iliffe & Sons, Ltd., London, England**

**Price 20 shillings net 460 pages**

The fourteenth edition of the British Plastics Year Book has been arranged in nine sections, to simplify the locating of information. The first section presents a historical review of the plastics industry, followed by recent patents on amino resins, cellulosic plastics, ethenoid and phenolic resins and nylon material. Section Two lists materials and manufacturers, and Section Three gives the makers of the products produced from the aforementioned materials. The next three sections are devoted to equipment manufacturers and contain a list of addresses of all firms mentioned. The final three sections include: a who's who of the industry; associations, trade organizations and institutes; and much data of practical use in the industry.

★ THE MANY APPLICATIONS OF Bakelite, Bakelite resin baking coatings and Vinylite are profusely illustrated in two brochures, "Bakelite and Vinylite Plastics," published by Bakelite Corp. and Carbide and Carbon Chemicals Corp., Plastics Div., New York, N. Y., and "Bakelite Resin Baking Coatings," released by Bakelite Corporation. The booklets contain complete descriptions of the materials and, in addition, list their properties and characteristics. A detailed listing of all the products marketed by the two companies is included in the booklet entitled "Bakelite and Vinylite Plastics."

★ "FOUR YEARS' PIONEERING IN Plastics Education" catalogs the teaching and administrative personnel and the curriculum, shop, laboratory and research facilities available at the Plastics Industries Technical Institute. This school maintains offices in New York City, Chicago and Los Angeles.

★ BRITISH PLASTICS FEDERATION, 48-48, Piccadilly, London W1, England, has published a report by the Sub-Committee on Costing, of its Injection Molders Section. This report first discusses the need for accurate costs, and then goes on to define costing, giving the value of uniform costs, the necessity of linking financial and costing records, the benefits of standard costs and the progress made toward uniform costs. There are chapters on elements of cost, material, labor, indirect expenditures and special problems as well as a specimen cost sheet.

★ "CUTTING PLASTICS WITH Circular Saws," a 32-page brochure published by Simonds Saw and Steel Co., Fitchburg, Mass., covers the types of circular saws used in cutting machines for plastics. Such details as specifications, stiffening collars, pitch and tooth space and hook of teeth are described in detail. Tables, charts, diagrams, and a list of typical troubles and their cure aid the reader in making the proper choice of machine.

★ THE COMPLETE LINE OF equipment manufactured by National Erie Corp., Erie, Pa., is presented in "Equipment for Rubber and Plastics," an illustrated 32-page brochure. Strainers (dehydrators), hydraulic jacks, extruders, tubers, mixing mills, hydraulic presses, pump units, tilting-head presses and plastic working equipment are discussed.

★ DOW CHEMICAL CO., MIDLAND, Mich., discusses the use of saran film and Stripcoat as packaging materials in a new 32-page brochure, which is effectively illustrated by Peter Muller-Munk, industrial designer. Unsealed, sealed waterproof and dehydrated treatment (box-in-bag-in-box and floating bag), are the three methods involved. Graphs and charts illustrate the physical properties of the materials — moisture, impermeability, incombustibility, bursting strength, aging and light stability, flexibility at low temperatures and chemical resistance.

★ A 24-PAGE BROCHURE ON THE use and care of micrometers has been received from Sav-Way Industries, Detroit, Mich. The booklet is primarily designed to introduce Sav-Way master setting and checking rolls for micrometers and other precision measuring instruments. The micrometer is "dissected" and its functions explained.


CASHEW NUTS

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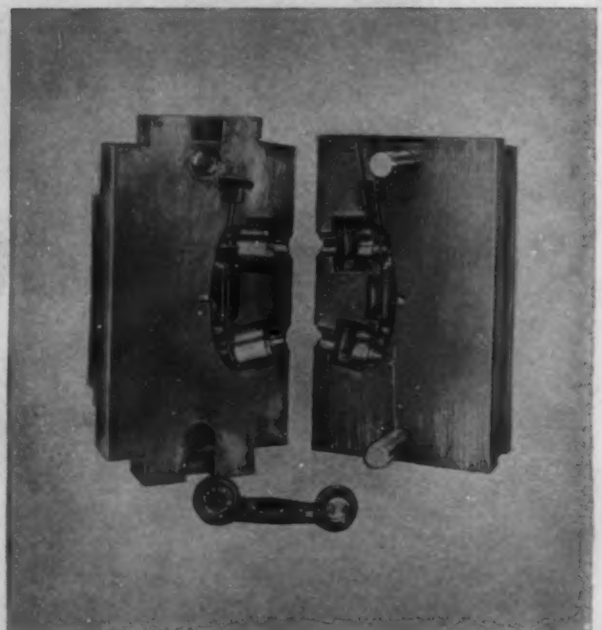

When choosing your molder, consider whether he makes his own molds. If he does, it usually means a better, faster job . . . often a more economical job. Then look at molds he has made. The skill and the care that are demonstrated in their construction are a sound measure of the worth of the final job.

The molds of the telephone handset which are shown here were made by Auburn for Stromberg-Carlson. Because the wires used for connections to the transmitter and receiver must be molded accurately in place in the handle, with the terminals properly positioned, the *transfer* molding process was used. By this process the molding material, in a plastic state, is forced into the mold after it has been closed. Note the several parts of the mold necessary to form the threaded transmitter and receiver shells, the hole for the cord and the opening in the handle in which a switch will be assembled.

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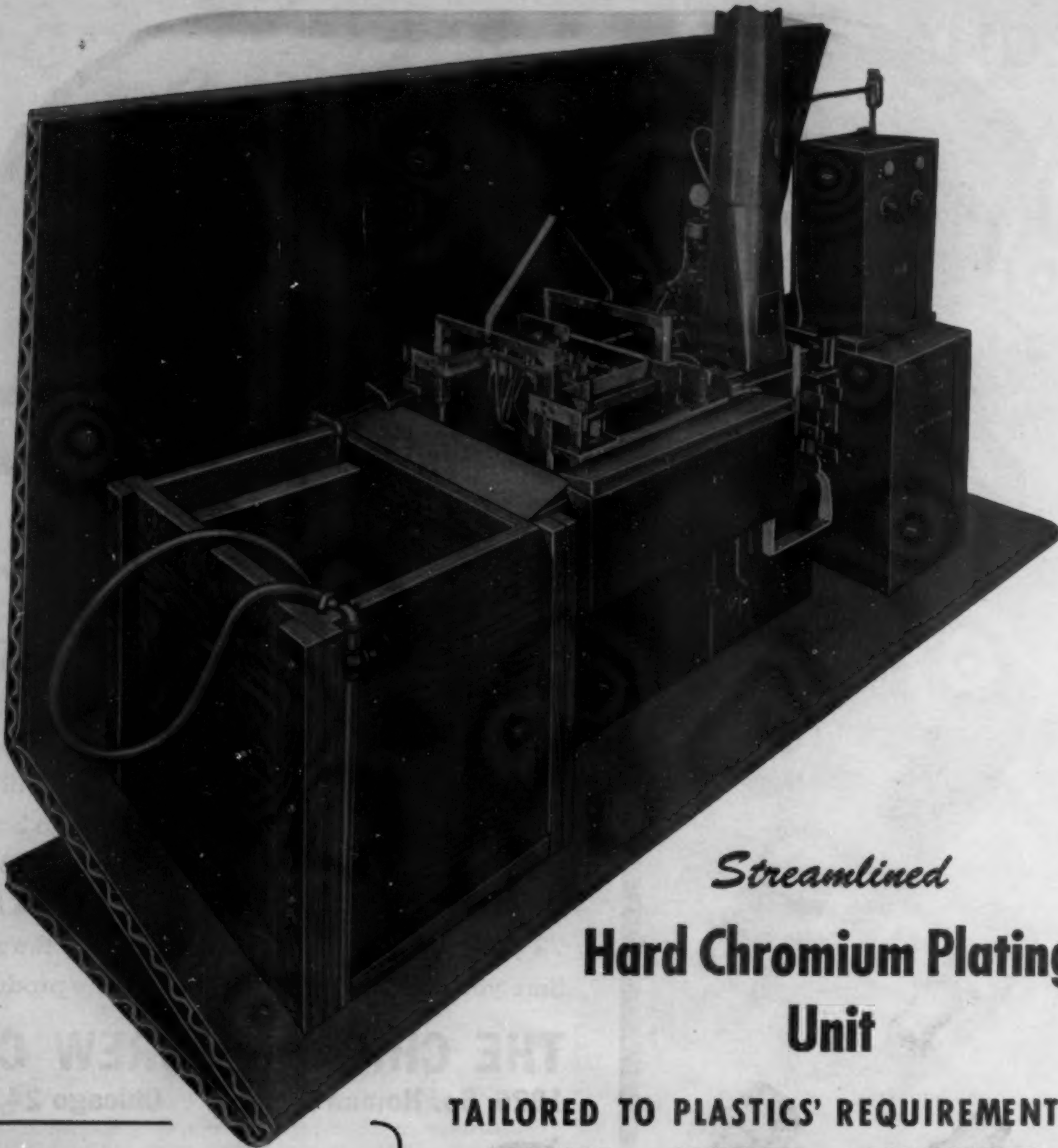

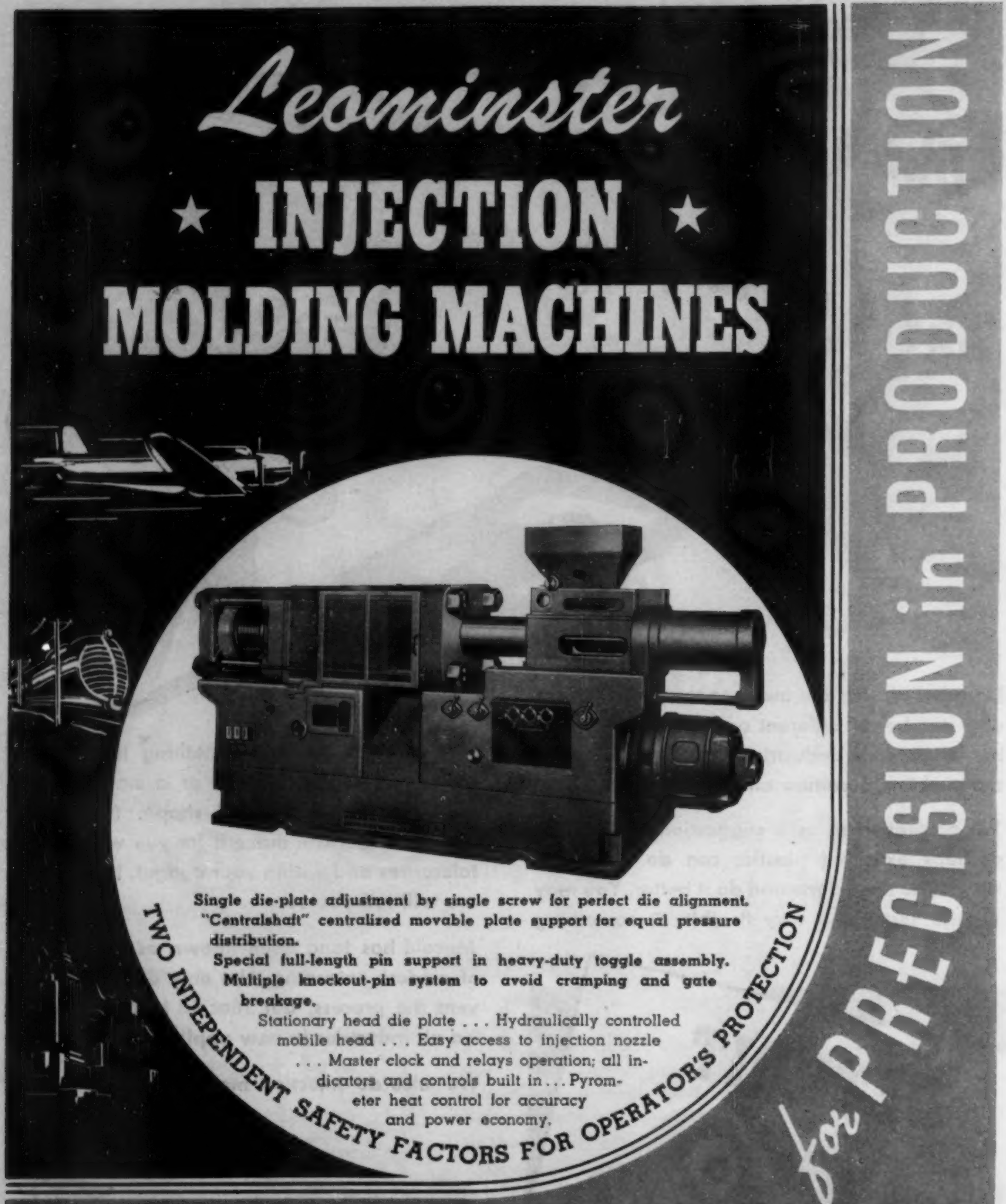
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11-LM-1

# NEW MACHINERY AND EQUIPMENT

★ TO FACILITATE BAKING, DRYING, dehydrating and preheating operations, Fostoria Pressed Steel Corp., Fostoria, Ohio, has designed a portable infrared unit known as model P-7-IR, so flexible in use that it is applicable to singular or multiple assemblies. It is reported to reduce process time to a minimum and provide a method for utilizing infrared energy without standby losses of electricity.

★ D. C. COOPER CO., CHICAGO Ill., has developed a special-jacketed kettle for heating ethyl-cellulose compounds. The unit is heavily insulated throughout, and has a heat range up to 400° F. A special heat-transfer oil is contained in the jacketed portion of the kettle, insuring even temperature at all times. The kettle is electrically heated and equipped with thermostat control.

★ TOOL STEELS CAST TO SHAPE are finding use in such commercial applications as dies, forming tools, molds, gages, hobs, gears and cams. Cast-to-Shape Div., Jessop Steel Co., Washington, Pa., claims that the most pronounced advantages obtained by this process are savings of time, labor, material and machining costs. Dies needed for immediate production are cast to required shape and need only a minimum of machine finishing, all castings being furnished in the annealed condition to facilitate machining.

★ CLEVELAND WORM AND GEAR Co., Cleveland, Ohio, has announced a new Speedaire fan-cooled worm gear reduction unit which provides its own air-conditioning system—removing the heat and giving more horse-power per hour. The Speedaire dissipates heat by passing it through an oil bath to the outer walls of the reservoir where deep fins increase radiating area by nearly 100 percent. The air is held to a directed course, effectually scouring the ends, sides and base of the reservoir as it is drawn across the finned surfaces from a grill at the opposite end of the unit. When operated at the usual motor speeds, this unit is said to deliver up to twice the horse-power capacity obtainable from standard-type worm reducers of equal size.

★ TWO NEW INSTRUMENTS ARE announced by Bristol Co., Waterbury, Conn.: a potentiometer pyrometer and an electronic controller. Model 431 Pyromaster Potentiometer Pyrometer for time-program control automatically regulates temperature. In addition, blank metal cams with time and temperature graduations printed on the cam face enable the user to cut his own cams with a pair of tin snips.

The free-vane electronic controller operates on the shielding effect of a vane passing between two coils in an electronic circuit. Recording and indicating models provide automatic control of temperature, pressure, liquid level and humidity. The temperature controller is offered in ranges from −125 to +1000° F. The pressure controller is available in ranges from full vacuum to 6000 lb. per square inch.

★ OUTSTANDING FEATURES OF the new motorized 10- and 20-ton presses, manufactured by Reimuller Brothers Co., Franklin Park, Ill., are all steel construction throughout, and simple hydraulic control. Ram movements through feed, hold or return position are controlled by a hand-lever hydraulic valve. Other important elements of the press are a hollow large area ram for holding punches and other fixtures, a lapped ram, packless design and twin pressure gages showing pressure and tons.

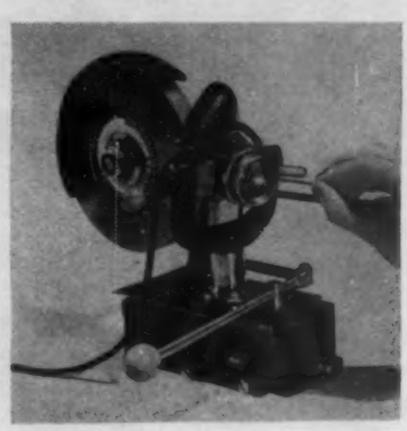
★ CROZIER MACHINE TOOL CO., Hawthorne, Calif., has adapted the Crozier tool-post turret for cutting-off operations. The channeled size of the block receives a standard beveled section cut-off blade, supported at the top by a hardened channeled bar, which provides maximum bearing surface for the locking bolts. The blade is thus centered and held in correct vertical position. The holder does not overhang and only sufficient tool extends to the required depth of cut. This arrangement is designed to give perfect rigidity, materially reduce set-up time and increase production.

★ THE OTSEGO SPEED CHUCK and Expanding Arbor, produced by Morrison Holmes Co., Detroit, Mich., is understood to be particularly well adapted to secondary operations, and to burring and polishing. It may be used as a collet chuck on speed lathes or as a holding fixture for drill press or milling machine. The chuck is available in two sizes: the junior model with a collet range of $^1/_8$ to $^7/_8$ in. and an adapter for $1^1/_2$ in. 8-thread spindles; and the senior model with a collet range of $^7/_8$ to 2 in. and an adapter for any spindle larger than $1^1/_2$ in. The arbor comes in a range of sizes for both chucks.

★ A METAL CUTTING BAND SAW, manufactured by Machine Tool Div., Kalamazoo Tank and Silo Co., Kalamazoo, Mich., is designed to cut tubes, rods, angles, heavy round or flat stock as well as odd and unusual shapes, with equal speed. Ease of operation and speed are achieved by means of continuous cutting. The machine is said to combine flexibility, speed and capacity with smoothness, accuracy and safety.

★ ROBERT H. CLARK CO., BEVerly Hills, Calif., is manufacturing a new adjustable tool holder with a vise grip for use in lathes, shapers and planers. Four or more sizes of tools may be used in the same holder—an arrangement that enables the mechanic to change sizes without changing holders. Possibility of a pocket or sag in the bottom of the holder is said to be eliminated by use of a special vise grip jaw which has a unique clamping action for holding the bit vertically and horizontally with evenly distributed pressure.

★ MERCURY PRODUCTS CO., Cleveland, Ohio, has developed a Tombill drill sharpener to solve production drilling problems. There are no cams in this sharpener. Each rotating movement is



on centers and is automatically taken up by spring tension. The unit can be used with any standard 6-in. or smaller grinding wheel, and even inexperienced workers can operate it. Since each size drill takes a different bushing, 10 bushings of the user's size are supplied with every sharpener.

★ A BENCH CENTER UNIT, COMbining the latest developments for accuracy and convenience, has been produced by Delta Mfg. Co., Milwaukee, Wis. The machine offers unique advantages in the design, construction and operation of the indicator support bracket. The base of the bracket can be locked in position by operating a handle at the front. Clamp handles make it unnecessary for the operator to use pliers or wrench to clamp any part in place. Head and tail stocks can be reversed so that the unit may be operated from either side.

# WASHINGTON ROUND-UP

R. L. VAN BOSKIRK, Washington Editor

### WPB liberalizes Chemical Order M-300

A new amendment to M-300, issued Oct. 2, 1944, gives considerably more leeway to suppliers in distributing material left over after materials of highest essentiality have been provided for. Up until that date, WPB maintained specific control over any production of a given chemical that might remain after all military requests had been allowed. It was the general policy for the Chemicals Bureau to allocate the remaining material into what officials thought were the highest essential uses. Under the terms of the new amendment it will be possible for suppliers to make that distribution themselves under one of the following methods:

1. When any material is left after highest essential items are supplied, the Chemicals Bureau may then authorize the supplier to ship such material to any customer he chooses. The customer may use it for any purpose he wishes.
2. The Chemicals Bureau can authorize a specified quantity of material, after war-service items are provided for, which may be shipped to any customer provided it is used for a designated purpose.

Whether or not the terms of this amendment will be applied to plastics depends upon availability of the particular material involved. Obviously it cannot be applied to materials of which there is no more than enough for military uses.

As expressed by a Chemicals Bureau official, the purpose of the order is to make an orderly retreat from the civilian field, while protecting the interests of the Armed Forces, as long as material is scarce.

### Injection machine allocations

The Chemicals Bureau allocations for September included the disposition of all injection machines listed for fourth quarter delivery. Of the 68 machines available, 60 were allocated. But 3 of the 60 were refused by the applicant. WPB is keeping the balance for emergency use as directed by the Armed Forces.

### Laminators hit by raw material shortages

The fortunes of war as reflected in recent successes of the Allied Armed Services seem to have operated in reverse for the laminators. Along about May and June everything looked so favorable that plans were being made to relax restrictions on decorative laminate for a wide variety of hitherto forbidden uses for civilian applications. But almost immediately after that period, shortages in various materials began to develop.

The latest development is that October allocations for varnish to be used on civilian applications were cut because of the formaldehyde situation and November allocations will probably suffer even more because of the formaldehyde situation. This situation on top of the variable cresol supply over the last few months is no help in relieving the confusion.

The fabric shortage also, may cut into military supply. Constant pressure by Army and Navy officials finally brought about issuance of Directive Number 1 to M-91 which practically impounded all cotton duck stocks of 500 yd. or more in inventory on Sept. 16. Laminators immediately pointed out that thousands of dollars worth of military orders would be held up if they could not use the cotton duck in inventory or obtain additional supplies.

After considerable activity by the various WPB units concerned, the directive was amended. The two types of duck (flat and army) most commonly used for military contracts, were released from inventory-freeze, but numbered and shelter-tent duck remain frozen in inventory.

The problem of where to obtain new cotton duck supplies seems to be getting more serious each day. It is all under direct allocation for Army and Navy use. The Government says that all cotton goods are "tighter" than at any other period during the war and will continue scarce for a period varying from one to two years after Germany's collapse. Authorities say that even denim for work clothes and fabric for civilian tires may have to be sacrificed so that the looms may be converted to cotton duck for tentage. Consequently laminators will simply have to join the mad rush and get fabric where they can. Most of them have only small inventories; one of the largest reported only a 3-wk. supply on hand.

It is true that almost all laminated materials eventually go into war applications. It should be remembered that the reason for consigning all duck to the Army and Navy was to prevent its use for civilian items such as awnings and the like. If a laminator can prove that he will be unable to make an important war item because he lacks fabrics, he will obtain support from the proper Armed Forces authorities. If the Army or Navy wants that item they will see that material is supplied, but it will be best to do as much shopping around as possible before making a claim.

### Formaldehyde shortage

Formaldehyde is an important ingredient in phenolic, urea and melamine molding powders, laminating varnishes and adhesives. The only raw material used in the manufacture of formaldehyde is methanol. Methanol is tight today because some of the plants where it is manufactured were equipped to produce either methanol or ammonia. Until recently these plants were turning out methanol but now they have been converted to ammonia production. Consequently there is less methanol for the manufacture of formaldehyde.

As a result of this shortage, WPB officials are warning all formaldehyde users of a probable cut-back. Consequently laminators and compression molders may expect to see some of their requests for phenolic and urea varnish and molding powders reduced. October was the first time in many months that urea molding powder, varnish or adhesives applications were not granted in full. Urea applications were cut more severely than phenolic because their end-use pattern is lower in the essentiality rating. But even phenolics may suffer a small degree of curtailment in the near future.

### Vinyl Order M-10 transferred

Order M-10 (vinyl polymers) was revoked Sept. 27 and control transferred to Schedule 54 of General Chemicals Order M-300. In making the transfer several changes were incorporated in the new schedule. The principal changes are as follows: 1) A more precise definition of vinyl polymers as compared to vinyl polymer products. 2) While small order exemption remains at 50 lb., there is a new provision which permits use of 200 lb. for experimental purposes. The 200 lb. cannot be received in addition to a small order without authorization, but it can be received in addition to the regular allotment. 3) Applications must be made on Form WPB-2945 (formerly PD-600). The filing date is the 15th day of the month before the requested allocation month.

### Acetate scrap removed from control

Scrap was removed from all control under the acetate and butyrate order which was transferred last Sept. 16 to become a part of General Chemical Order M-300. Former Order M-326b is now Schedule 52 of M-300, but there are no other changes in the order. Acetate flake formerly M-326, is now controlled under Schedule 50; and sheets, rods and tubes will be controlled under Schedule 51. There are no changes in the flake or sheets, rods and tubes orders except their transfer to become a part of M-300.

# NEWS OF THE INDUSTRY

★ IN ORDER TO LAY A FIRM foundation for the expansion of Glyptal alkyd resins, General Electric Co. has reorganized its field force. The New York office will be located at 570 Lexington Ave., under the direction of F. M. Hastings; the Atlantic seaboard district will be handled by C. H. Gross, who will make his headquarters in Schenectady, N. Y.; P. E. Doell will be in charge of the East Central district with an office at 1966 Woodland Ave., Cleveland, Ohio; and the Central district will be under the supervision of J. R. Reid and R. C. Reid at 840 South Canal St., Chicago, Ill. The Paul W. Wood Co. of San Francisco and Los Angeles will represent the company on the Pacific coast, and J. E. Russell will act in a similar capacity in Arkansas, Louisiana, Oklahoma and Texas.

★ THE BOARD OF DIRECTORS OF Catalin Corp. has announced thee lection of Alan N. Mann as chairman of the Board and of Harry Krehbiel as president and chief executive officer. Mr. Mann has been associated with the company for

H. KREHBIEL A. N. MANN

about 11 years as patent counsel, vice-president and director. Mr. Krehbiel, who has been with Catalin Corp. for the past 13 years, has served as vice-president and director.

★ BENDIX-MARINE DIV., BENDIX Aviation Corp., has moved its offices and manufacturing departments to 106 Nostrand Ave., Brooklyn 5, N. Y.

★ CATALIN CORP. ANNOUNCES the opening of a new office in Suite 1119, 221 N. LaSalle St., Chicago, Ill., under the supervision of I. F. Ferguson. All sales of Catalin, Loalin, Catabond, Catavar and Catapak in the Midwestern area will be directed from this office.

★ MAURICE C. BACHNER HAS REtired from active participation in the affairs of Chicago Molded Products Corp., Chicago, Ill. Mr. Bachner had served in the capacity of president and chairman of the board.

★ DR. WALTER S. LANDIS, VICE-president and director of American Cyanamid Co., New York, N. Y., and an outstanding authority in the fields of chemistry and metallurgy, died suddenly of a heart attack.

★ GRAYSON W. WILCOX HAS REturned to his position in Durez Plastics & Chemicals, Inc., North Tonawanda, N. Y. Mr. Wilcox has been serving as Deputy Chief, Plastics Div., War Production Board, for the past two years.

★ A NEW OFFICE HAS BEEN opened by Hercules Powder Co. in the Union Commerce Bldg., Cleveland, Ohio, under the management of W. Wallace Trowell of the Wilmington office. John L. Present will act as technical representative. This branch office will handle Synthetics Dept. sales in Michigan, Ohio, western New York, western Pennsylvania and Ontario, Canada.

★ THE REPUBLIC PLASTICS Corp., 1032 North Kolmar Ave., Chicago, Ill., has been formed by W. C. Jerome, E. F. Bachner, Jr., and M. F. Bachner, for the manufacture of transfer, compression, injection and extrusion molded parts and assemblies.

★ G. J. HAAN HAS BEEN APpointed vice-president and general manager of Cruver Manufacturing Co., Chicago, Ill. Mr. Haan was previously associated with National Lock Co. and Keeler Brass Works.

★ ISLYN THOMAS, GENERAL works manager, Ideal Plastics Corp., Long Island City, N. Y., is resigning his present position in order to establish in the very near future, a new business enterprise which will be associated with the plastics industry. More specific details will be announced at a later date. Mr. Thomas is also connected with the Brooklyn Polytechnic Institute as an E.S.M.W.T. instructor.

★ H. B. HIGGINS, PRESIDENT OF Pittsburgh Plate Glass Co., Pittsburgh, Pa., has announced plans for an addition to the company's Creighton, Pa., plant, which will increase its capacity for the production of polished plate glass, laminated glass products and glazed assemblies for aircraft.

★ THE GENERAL OFFICES OF H. L. Yoh Co., industrial consultants, have been moved to 321-323 Chestnut St., Philadelphia, Pa.

★ MONSANTO CHEMICAL CO. will open a general sales office in Seattle, Wash., at 911 Western Avenue, headquarters of I. F. Laucks, Inc. C. F. Trombley as branch manager will represent all company items other than Laucks properties, under the supervision of E. Schuler, general branch manager of West Coast territory.

★ FOR THE BETTER HANDLING of war orders and the development of an improved organization with which to enter the postwar field, Quaker Oats Co., Chicago, Ill., has formed a chemicals department. The Furfural and Technical Divs. will merge in this department under the direct management of Dr. Lauren B. Hitchcock.

★ U. S. MENGEL PLYWOODS, INC., Louisville, Ky., has opened its third plywood distributing unit in Atlanta, Ga. This warehouse will be under the supervision of J. P. Burford who is also in charge of the Jacksonville branch.

★ R. C. WILSON HAS BEEN APpointed sales manager of the Buffalo Div., Farrel-Birmingham Co., Inc., Ansonia, Conn. He will be in charge of sales of gears, gear units, flexible couplings and related products.

★ IN CONJUNCTION WITH THE expanded research and product development activities of Continental Carbon Co., New York, N. Y., Dr. Leonard H. Cohan has been appointed director of research in charge of the Chicago and Sunray, Texas, activities.

★ PRODUCT DESIGNERS, A NEW organization of industrial designers and engineers, has been formed in Chicago with offices at 230 North Michigan Avenue.

★ I. F. LAUCKS, INC., HAS COMbined its eastern sales office at Chicago, Ill., with its laboratories and plant at Lockport, N. Y. This change will apply to both the company's glue and Laucks coatings and wood preservative sales.

## Sorry!

★ WITH REFERENCE TO THE ARticle on Allyl Plastics appearing in the August, 1944, issue (page 97), Pittsburgh Plate Glass Co. points out that the term "Allymer" is applied only to the monomeric form of the series of allyl resins formerly known as Columbia Resins, i.e., these monomers are now designed as Allymer CR 39, Allymer CR 149, and so forth.

# Heat resistance of laminates

*(Continued from page 154)* The paper-base Grade XXP, which is next best, is characteristic of paper-base laminated phenolics. In these grades the general slight shrinkage in all directions may be attributed to loss of plasticizer or volatile ingredients of the resin and paper. Shrinkage in length and width and increase in thickness is observed for the fabric-base grades. A possible explanation is reorientation of the fibers in the yarns of the fabric.

The same grades shown in the dimensional change data were also tested for change in flexural strength. The data are given in Table V.

At this extreme temperature, 225° C. or 437° F., all the materials show a rapid decrease in flexural strength lengthwise, the cotton-fabric base Grades CE and LE dropping off approximately 50 percent in the first hour, and after 14 hr. showing only 15 to 20 percent of initial strength. The Grade AA material loses about 30 percent of its initial strength in 1 hr. and then remains practically constant for the 14-hr. period. This initial loss is presumably due to the cotton content of the asbestos cloth. These particular samples were made from type AA asbestos fabric. Figure 8 shows the trend of these grades. Grade XXP rather surprisingly holds up for the first 10 hr. better than the AA but then rapidly decreases. Results on tests in the crosswise direction showed very similar trends and therefore are not included.

### Effect of heat on asbestos material

A study has been made of change in flexural and impact strength on phenolic laminated sheets made from Underwriters and from Type AA fabrics using the same resin and resin contents. These data are presented in Table VI. The Underwriters grade, 80 percent asbestos and 20 percent cotton, showed a loss of about 25 percent in impact strength in 7 days at 160° C., while the Type AA, 90 percent asbestos and 10 percent cotton, showed practically no change under the same conditions. Laminated sheets from Underwriters-type fabric show actual original impact-strength values only about 70 to 75 percent of those for type AA. For flexural strength, there are no marked changes for these heating conditions with either grade of fabric. This behavior for increased cotton content is be expected from the curves in Fig. 8.

### Effect of longer heating periods at various temperatures

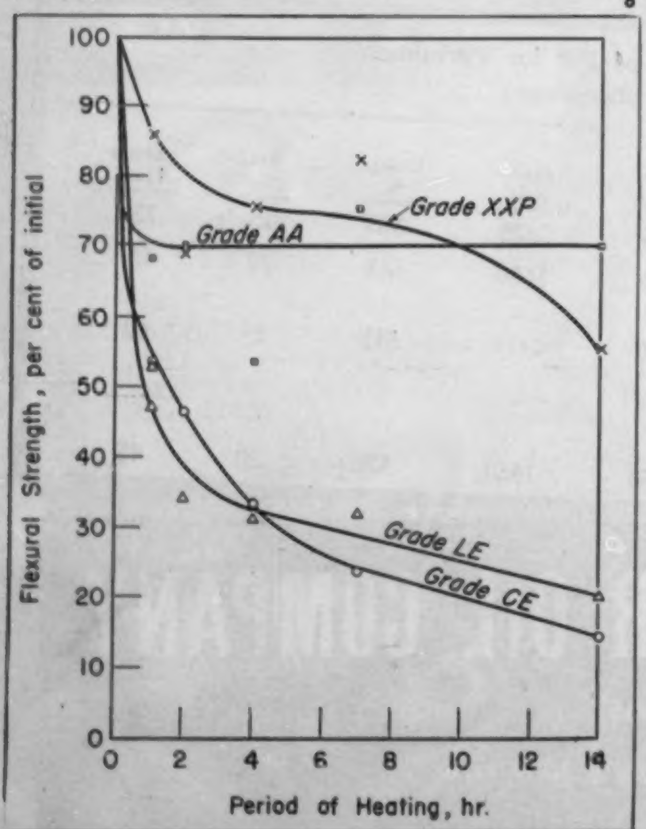
*Effect on flexural strength*—A more extensive investigation was undertaken to study effect of heating for longer periods upon flexural and impact strength. This included heating for 7-day periods at various temperatures up to 250° C.

Curves for the less heat-resisting grades are shown in Fig. 9 and the data are given in Table VII. The cotton-fabric-base grades show no appreciable decrease in flexural strength up to 100° C. but have practically no strength left at 200° C. The cellulosic materials such as Vulcoid and Diamond Dilecto show no appreciable loss up to 150° C., then very rapidly decrease up to 200° C. where strength is practically nil. The paper-base phenolics XX and XXP begin to fall off at about 165° C., still retain about 50 percent strength at 200° C., and fall off to practically zero at 250° C.

Figure 10 represents the same conditions for some of the better heat-resisting grades. The detailed data are given in Table VII. At 150° C., none of these materials show any appreciable change while some actually show improvement in flexural strength. The glass-base grade was by far the best, showing no appreciable loss even at 250° C. after 7 days of heating. The asbestos-fabric-base Grade AA was next

*8—Effect of temperature of 225°C. on flexural strength. 9—Effect of exposure at various temperatures on flexural strength of less heat-resisting grades. 10—Effect of same condition as in Fig. 9 on better heat-resisting grades*

8

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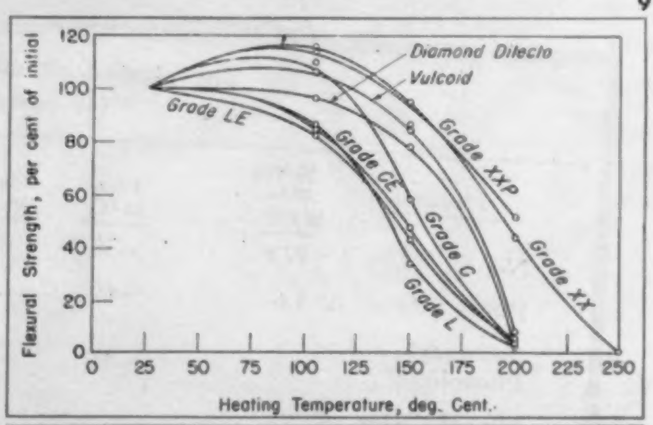


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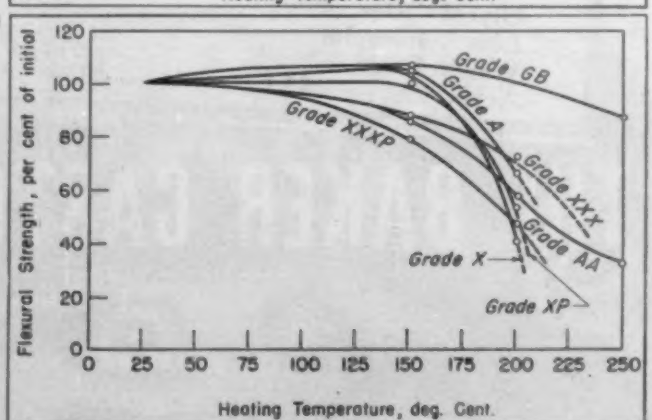

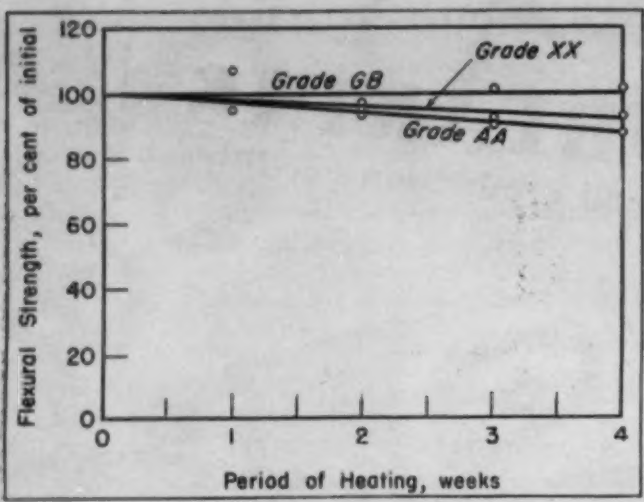


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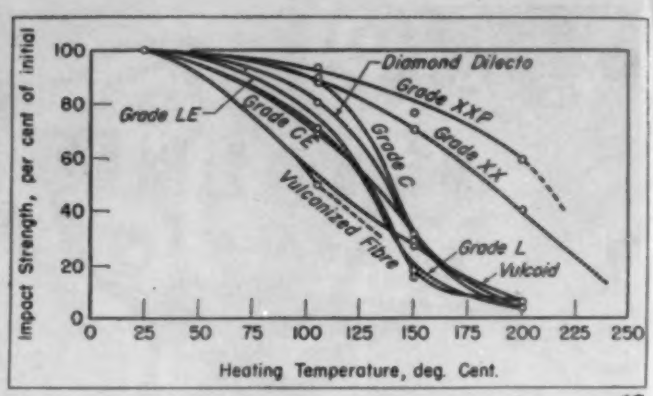


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**11**—***Results of longer exposure tests on flexural strength of better heat-resisting laminates.*** **12**—***Changes in impact strength for less heat-resisting grades of materials***

best, but retained only 35 percent of its strength at 250° C. This sample was made from Underwriters grade of asbestos fabric containing approximately 20 percent cotton. The paper-base asbestos Grade A drops off rapidly in strength because of a tendency to blister, so that the high resin content cellulosic-paper-base grade is better in heat resistance.

Figure 11 shows results of longer exposure tests on flexural strength of some of the better heat-resisting laminated materials, and indicates the stability of all of them, namely, Fiberglas base, asbestos fabric base, and high resin content cellulose paper base at 150° C. even for a 4-week period.

*Effect on impact strength*—The curves in Fig. 12 indicate the changes in impact strength for the less heat-resisting grades. Here the losses are considerably greater than for flexural

TABLE VII.—DECREASE IN FLEXURAL STRENGTH[a] OF PHENOLIC LAMINATES AFTER EXPOSURE AT VARIOUS TEMPERATURES

| *Material* | *Flexural strength as received* | *Percentage of initial flexural strength after exposure for 7 days to:* 105° C. | 150° C. | 200° C. | 250° C. |
|---|---|---|---|---|---|
| LESS HEAT-RESISTANT: | *p.s.i.* | % | % | % | % |
| | | Lengthwise | | | |
| Vulcoid | 26,300 | 106 | 84 | 8 | .. |
| Diamond-Dilecto | 35,600 | 97 | 78 | 4 | .. |
| XX | 19,200 | 116 | 95 | 44 | 0 |
| XXP | 15,700 | 115 | 86 | 52 | .. |
| C | 19,600 | 110 | 58 | 3 | .. |
| CE | 22,300 | 85 | 48 | 3 | .. |
| L | 25,200 | 87 | 34 | 2 | .. |
| LE | 22,600 | 83 | 43 | 5 | .. |
| | | Crosswise | | | |
| Vulcoid | 19,200 | 106 | 84 | 10 | .. |
| Diamond-Dilecto | 21,200 | 92 | 70 | 6 | .. |
| XX | 17,400 | 101 | 84 | 59 | 0 |
| XXP | 13,700 | 123 | 101 | 57 | .. |
| C | 19,300 | 97 | 55 | 3 | .. |
| CE | 21,000 | 80 | 46 | 2 | .. |
| L | 20,400 | 90 | 32 | 2 | .. |
| LE | 15,000 | 80 | 40 | 6 | .. |
| MORE HEAT-RESISTANT: | | | | | |
| | | Lengthwise | | | |
| X | 30,300 | ... | 105 | 41 | .. |
| XP | 21,900 | ... | 101 | 54 | .. |
| XXX | 18,800 | ... | 88 | 74 | .. |
| XXXP | 16,700 | ... | 80 | 48 | .. |
| A | 22,800 | ... | 106 | 67 | .. |
| AA | 17,100 | ... | 87 | 58 | 33 |
| GB | 31,000 | ... | 107 | 101 | 88 |
| | | Crosswise | | | |
| X | 24,100 | ... | 100 | 47 | .. |
| XP | 18,400 | ... | 101 | 52 | .. |
| XXX | 15,700 | ... | 92 | 80 | .. |
| XXXP | 12,800 | ... | 95 | 56 | .. |
| A | 13,300 | ... | 102 | 73 | .. |
| AA | 16,400 | ... | 85 | 55 | 30 |
| GB | 24,600 | ... | 100 | 87 | 78 |

[a] Tests made at 25° C. on specimens 3 by 1/2 by 1/8 in. cooled to that temperature.

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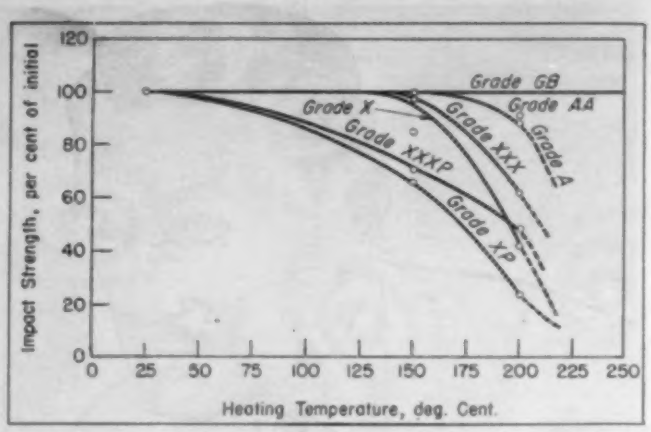
strength even at 100° C. The only significant change in order of the various materials is with the Vulcoid which shows a very sharp drop off even at 65° C. This decrease, as in the case of vulcanized fibre, is due primarily to loss in moisture. At higher temperatures the loss in all of the regenerated cellulosic-base materials is probably largely due to degradation of the cellulose itself. Paper-base materials of the higher resin content again show the least change. The detailed data are shown in Table VIII.

Figure 13 shows the effect of 7 days' heating at various temperatures on edgewise impact strength for the more heat-resisting grades. Grade GB, Fiberglas base, and AA (made from Grade AA asbestos fabric) show no change in impact even at 250° C. for the 7-day period. The order of the other grades is about the same as for flexural strength except for A, asbestos paper, which assumes the third best position. The detailed data are presented in Table VIII.

While the previous curves show the percentage changes based on the initial impact strength, they may not indicate well the magnitude of the original impact values and the changes. Figure 14 shows the relative impact strengths of




**13**—*Effect of 7 days heating at various temperatures on edgewise impact strength of more heat-resisting grades*

Grades GB, AA, C, A and XX. The magnitude of the impact values and the trends at increasing temperature are as might be expected from the accepted values and the data

Table VIII.—Decrease in Impact Strength* (Izod Notch) of Phenolic Laminates after Exposure at Various Temperatures

| *Material* | *Izod impact strength as received* | *Percentage of initial impact strength after exposure for 7 days to: 105° C.* | *150° C.* | *200° C.* | *250° C.* |
|---|---|---|---|---|---|
| | *ft.-lb./in. of notch* | % | % | % | % |
| **LESS HEAT-RESISTANT:** | | | | | |
| | | Lengthwise | | | |
| **Vulcoid** | 2.57 | 50 | 28 | 7 | ... |
| **Vulcanized Fibre** | 2.28 | 54 | ... | ... | ... |
| **Diamond-Dilecto** | 1.98 | 81 | 29 | 5 | ... |
| **XX** | 0.51 | 89 | 71 | 41 | 0 |
| **XXP** | 0.35 | 95 | 77 | 60 | ... |
| **C** | 2.26 | 89 | 29 | 5 | ... |
| **CE** | 1.96 | 70 | 31 | 5 | ... |
| **L** | 1.97 | 71 | 16 | 5 | ... |
| **LE** | 1.57 | 75 | 18 | 8 | ... |
| | | Crosswise | | | |
| **Vulcoid** | 1.83 | 54 | 37 | 6 | ... |
| **Vulcanized Fibre** | 1.66 | 64 | ... | ... | ... |
| **Diamond-Dilecto** | 1.21 | 85 | 38 | 8 | ... |
| **XX** | 0.43 | 100 | 75 | 49 | ... |
| **XXP** | 0.44 | 100 | 77 | 65 | ... |
| **C** | 1.90 | 87 | 29 | 5 | ... |
| **CE** | 1.83 | 69 | 34 | 6 | ... |
| **L** | 1.71 | 57 | 13 | 5 | ... |
| **LE** | 1.16 | 63 | 21 | 7 | ... |
| **MORE HEAT-RESISTANT:** | | | | | |
| | | Lengthwise | | | |
| **X** | 0.62 | ... | 98 | 42 | ... |
| **XP** | 0.80 | ... | 66 | 26 | ... |
| **XXX** | 0.39 | ... | 100 | 62 | ... |
| **XXXP** | 0.41 | ... | 71 | 49 | ... |
| **A** | 1.27 | ... | 109 | 89 | ... |
| **AA** | 4.38 | ... | 85 | 105 | 100 |
| **GB** | 10.1 | ... | 123 | 100 | 98 |
| | | Crosswise | | | |
| **X** | 0.61 | ... | 93 | 46 | ... |
| **XP** | 0.74 | ... | 65 | 33 | ... |
| **XXX** | 0.32 | ... | 91 | 61 | ... |
| **XXXP** | 0.37 | ... | 73 | 57 | ... |
| **A** | 0.67 | ... | 104 | 90 | ... |
| **AA** | 3.57 | ... | 96 | 106 | 81 |
| **GB** | 8.0 | ... | 119 | 102 | 93 |

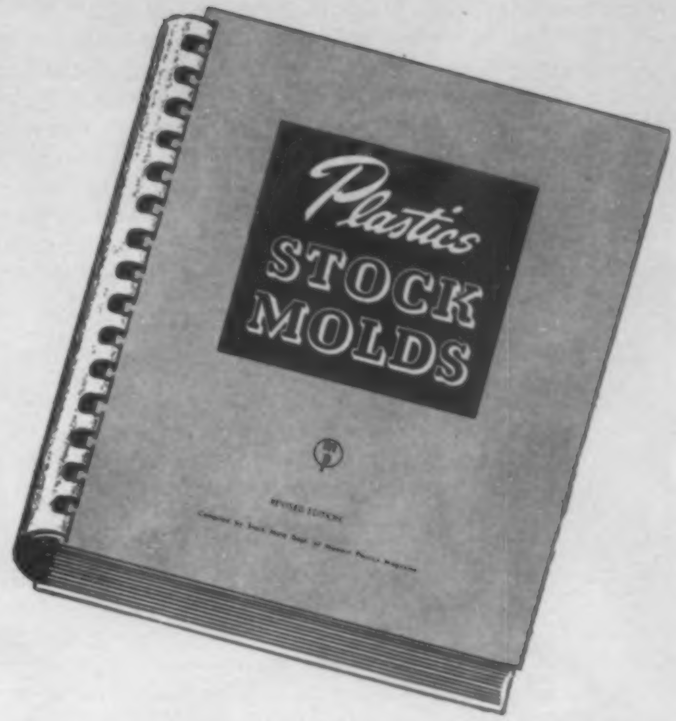
*** Tests made at 25° C. on material, 1/8 in. thick, cooled to that temperature. The impact values in this study were obtained by the standard A.S.T.M. Izod Method D 256–41 T which measures the total energy required to break and throw the piece away from the jaw. Some calculation for correction of energy absorbed in actually throwing off the broken specimen shows a change in the magnitude of the actual impact values but no appreciable change in the trends of the curves.**

# PLASTICS

# STOCK MOLDS

## *VITAL IN*

# RECONVERSION




One plastics user has recently stated that stock molds are absolutely indispensable in plastics reconversion. Likewise, they are vital to every user of plastics!

Modern Plastics' staff has collected nearly 1600 current plastics stock molds. These molds include flashlights, shaving accessories, textile accessories, hair ornaments, cosmetic containers, trays, office equipment, frames, household products, lamp bases, plumbing hardware, electric and general hardware, clock cases, medical applications, boxes and containers, handles, closures, knobs, smoking accessories, games and novelties, jewelry, etc., etc.

Every one of these molds is illustrated by a photograph of the item molded in it. Each stock mold is numbered and indexed by the name of the molder who owns it. Stock molds are all cross-indexed by subject.

Included as well are two brand-new special sections of material never before collected. The first is extrusions. All stock extruded parts are illustrated with cross-section drawings and are indexed both by the maker's name and by number. Likewise, all laminates including sheets, rods and tubes are listed together with the names of the manufacturers.

Already, hundreds of enthusiastic letters from buyers of the PLASTICS STOCK MOLD BOOK testify that the volume is not only important, it is absolutely indispensable to anyone who buys or uses plastics. As one important plastics user says, "this book is worth many times $5.00 to me and should have the same value to anyone. All you have to do is find the stock mold you can use and you have saved yourself hundreds or even thousands of dollars as well as a great deal of time and effort."

The number of copies of this book is strictly limited by current paper quotas. Orders are now being filled at $5.00 per copy (foreign and Canadian $6.00).

# PLASTICS

# STOCK MOLDS

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shown in the previous curves and in Table VIII. It may be noted that the values for Grade C decrease so rapidly that the curve crosses both A and XX curves at 175 to 200° C.

Three of the better heat-resisting grades, GB, AA and XX, were tested for impact strength after heating for 4 weeks at 150° C., and the trends of these grades are depicted in Fig. 15. These are quite similar to the flexural strength curves, the Grade GB being unaffected and the AA and XX showing about 20 percent decrease at the end of 4 weeks. The fabric used in the Grade AA phenolic laminate was in this case the Underwriters grade. Table IX shows the actual magnitude of the impact values while Fig. 16 gives the trends of those values due to exposure for 4 weeks at 150° C.

TABLE IX.—IMPACT STRENGTH[a] (IZOD NOTCHED) OF PHENOLIC LAMINATES AFTER EXPOSURE FOR VARIOUS PERIODS AT 150° C.

| Material | Value | —Impact strength after— heating at 150° C. for: 0 wk. | 2 wk. | 3 wk. | 4 wk. |
|---|---|---|---|---|---|
| XX | Ultimate, ft.-lb./in. of notch | 0.54 | 0.50 | 0.52 | 0.46 |
| | Percent of initial | 100 | 92 | 96 | 85 |
| AA | Ultimate, ft.-lb./in. of notch | 4.50 | 3.76 | 3.67 | 3.97 |
| | Percent of initial | 100 | 84 | 82 | 88 |
| GB | Ultimate, ft. lb./in. of notch | 8.39 | 8.40 | 8.63 | 8.94 |
| | Percent of initial | 100 | 100 | 103 | 107 |

[a] Tests made at 25° C. on material, 1/8 in. thick, cooled to that temperature. The values are the average of the data for lengthwise and crosswise specimens.

## Summary

The general conclusions from these tests are that glass-base laminates have the best heat resistance, showing practically no change in flexural or impact strength measured at room temperature for one week at temperatures up to 200° C. or for periods up to four weeks at 150° C. Asbestos fabric base is next best in heat resistance. This applies specifically to the material made from Grade AA asbestos cloth containing approximately 90 percent asbestos and 10 percent cotton. Materials made from the Underwriters grade of asbestos fabric are definitely less heat resistant. High resin content paper-base grades of the XX or XXX type were third best. Asbestos-paper-base grades tended to blister at the higher temperatures, while cotton-fabric-base phenolic materials and the regenerated cellulosic materials such as vulcanized fibre or its combinations with phenolic material lost practically all flexural and impact strength in one week at 200° C. and showed a marked decrease in strength even at 150° C. It should be noted that the fabric-base phenolics showed little deterioration in appearance even when impact strength and flexural strength were only a fraction of the original values.

The change in physical properties with change in testing temperature is a somewhat different problem. The work on this phase was limited to 90° C. and to a few grades. It indicated a significant decrease in strength for material tested hot, in some cases as much as 50 percent. With continued exposure to heat at 90° C. up to 1 month, the flexural strength, measured hot, of the phenolic laminated material increased and approached the cold strength.

Importance of standardization of testing temperatures and increments of temperature increase on both thermoplastic and thermosetting materials has been brought out in this work and that of Subcommittee V of A.S.T.M. Committee D-20. These principles have been incorporated in the proposed A.S.T.M. method for determining the heat resistance of these materials. This provides for setting up test temperatures in steps of 25° C. and, when failure occurs,

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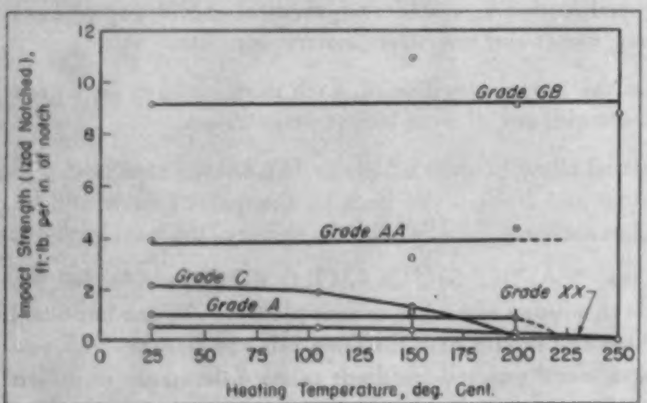


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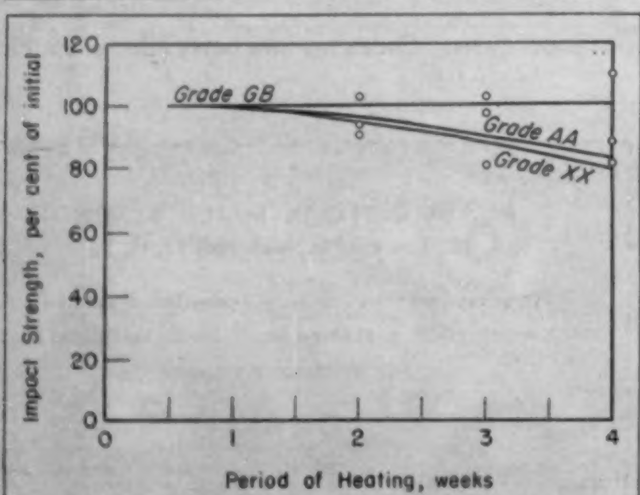
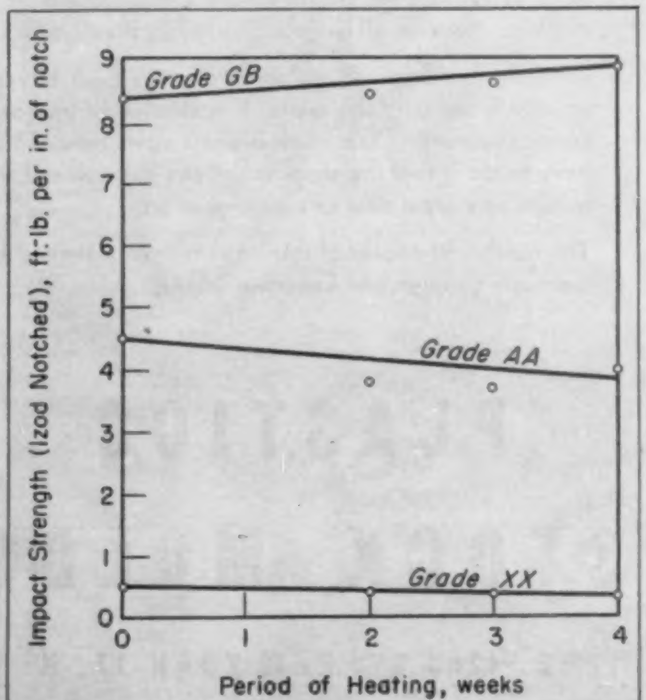



14—*Relative impact strength of Grades GB, AA, C, A and XX.* 15—*Effect of heating for 4 weeks at 150°C. on impact strength of Grades GB, AA and XX.* 16—*Trend of impact values due to 4 weeks' exposure at 150°C.*

16



for studying intermediate 10° C. steps. The highest temperature that the material will withstand without visible deterioration or objectionable change in the particular physical property chosen for study is taken as the criterion of heat resistance.

The tests described in this paper included only the standard laminated grades and a few other materials. The deterioration under heat of laminates may be due either to the degradation of filler or binder or of both. Some of the newly developed resins may show greater heat resistance. Also the effect on other physical and electrical properties can be studied by the same general procedure. The primary purpose of this investigation has been to develop a suitable test method for measuring heat resistance of laminated plastics. While many grades have been studied, no attempt has been made to include all of the materials nor all of the factors relating to heat resistance.

# Diffusion of water

*(Continued from page 156)* (Table IV), undoubtedly due to the numerous unesterified hydroxyl groups in the cellulose structure. The more complete acetylation of cellulose reduces the permeability appreciably as shown by the behavior of the triacetate.

The data in Table V show that the type as well as the amount of the plasticizer can affect the permeability considerably. The dibutyl phthalate and Dow No. 6 [di-(ortho zenyl) monophenyl phosphate] in the ethyl cellulose series show that a plasticizer can improve as well as impair the permeability characteristics. The unplasticized ethyl cellulose does not become sufficiently plastic with heat to mold properly and the diffusion value may be high. In the polyvinyl 95-chloride 5-acetate series the diffusion constants vary considerably for equivalent amounts of plasticizer. Similarly, the diffusion values for the Koroseal samples (Table II) which are polyvinyl chloride modified by the incorporation of different plasticizers, vary about the same amount. The relative rate with which the plasticizer itself transmits water and its degree of compatibility with the resin or polymer probably are important factors.

The addition of wax to an ethyl cellulose composition is an instance where the addition of an incompatible hydrophobic constituent reduces the permeability. However, such systems are not always stable. The diffusion constant of a composition containing 2 percent wax steadily decreases (Fig. 2)

TABLE V.—EFFECT OF PLASTICIZERS ON WATER PERMEABILITY

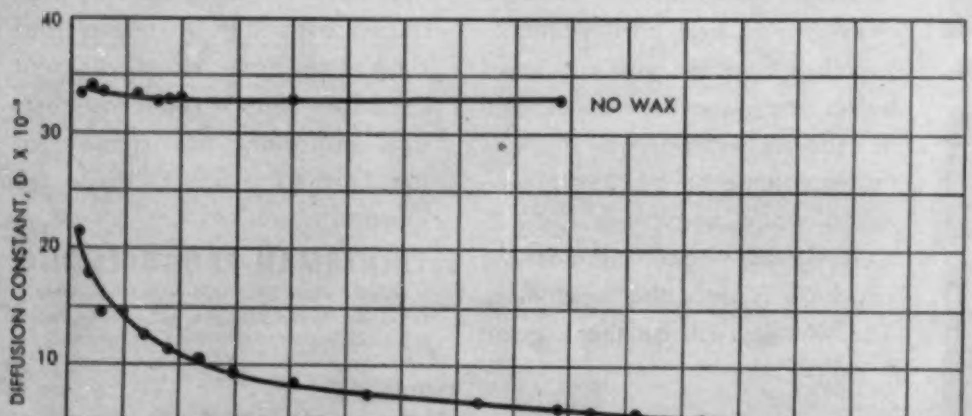
| *Material* | $D \times 10^{-8}$ |
|---|---|
| Ethyl cellulose | |
| Unplasticized | 77.0 |
| 5 percent dibutyl phthalate | 68.0 |
| 25 percent dibutyl phthalate | 73.0 |
| 45 percent dibutyl phthalate | 118.0 |
| 5 percent Dow No. 6 | 73.0 |
| 25 percent Dow No. 6 | 33.0 |
| 45 percent Dow No. 6 | 22.0 |
| Polyvinyl 95-chloride 5-acetate | |
| Unplasticized | 0.7 |
| 30 percent tricresyl phosphate | 2.7 |
| 30 percent Santicizer M17 | 4.4 |
| 30 percent dioctyl phthalate | 4.7 |
| 30 percent Flexol 3GH | 36.5 |

TABLE VI.—INFLUENCE OF FILLERS ON PERMEABILITY

| | | | | |
|---|---|---|---|---|
| Composition (by weight) | | | | |
| Ethyl cellulose (150 cps.) | 55.0 | 30.6 | 55.0 | 30.6 |
| Dibutyl phthalate | 45.0 | 25.0 | | |
| Dow No. 6 | | | 45.0 | 25.0 |
| Whiting | | 44.4 | | 44.4 |
| Diffusion constant $D \times 10^{-8}$ | 118.0 | 73.0 | 22.0 | 16.0 |

over a period of 2 months with visual evidence that the wax is being forced to the surface of the specimens, forming a continuous layer.

The addition of fillers to plastics also affects the rate of moisture diffusion. In Table VI are shown data on ethyl cellulose compounds containing whiting. The plasticizer-resin ratio is constant in the filled and unfilled compounds. If a calculation is made on the assumption that the inert whiting only displaces the water diffusing constituents in proportion to its volume in the compound, constants of 90 and 17 are obtained instead of the actual values of 73 and 16, respectively. This discrepancy might be attributed to the blocking action of the non-permeable filler which effectively increases the diffusion path. On the other hand the incorporation of a water sorbing filler in a resinous composition may produce the opposite effect. Whereas phenol-formaldehyde resin alone has a constant of $0.1 \times 10^{-8}$, the addition of 50 percent woodflour increases the permeability 30 fold. A prediction as to whether a particular filler will increase or decrease the permeability of a compound to water will depend on the moisture sorption and diffusion characteristics




*2—The effect of wax on the diffusion of water through an ethyl cellulose composition is evident in this chart*

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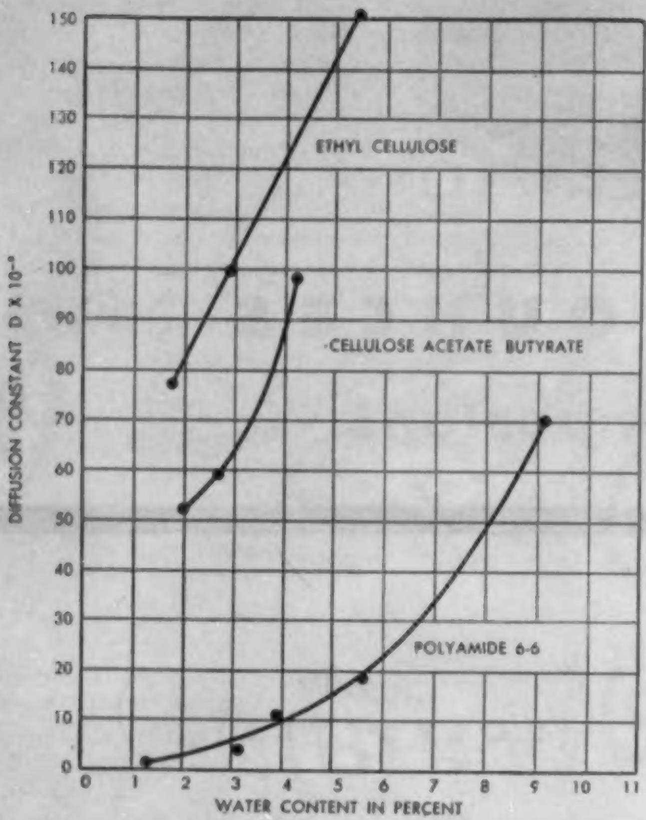



***3—Diffusion constant as a function of water content***

of the filler relative to that of resin. The effect of various fillers is described by E. Badum[3] for rubber compositions. He reports reductions in diffusivity as high as 70 percent for compositions containing 25 percent of filler by weight.

In addition to compositional factors, the method of preparing the samples also may affect the diffusion constant. For example, a cast film of unplasticized cellulose acetate is more permeable to water than a molded one (Table II). The permeability also may vary with the solvent used. When molding a phenolic material which contains a considerable amount of compressible filler, improper heat and pressure application produces an internally porous film which will give erroneous results. Moreover, brittle materials such as polystyrene may change during test because of crazing to give an increasing diffusion constant.

Fick's law states that the diffusion constant is independent of the vapor-pressure differential. Therefore, the same constant should be obtained whether a sample is tested with a pressure differential at a low or high relative humidity, i.e., the humidity conditions chosen to obtain $p_1$ and $p_2$ should not affect the result. In order to check this point, tests were run using water or calcium chloride in the cell, and saturated salt solutions outside the cell to establish the humidity conditions. These data are given in Table VII. The columns have been arranged from left to right so that a water sorbing specimen has an increasing water content at equilibrium. Examination of the data then reveals that the departure from Fick's law is in some way related to the sorption characteristics of the diffusion specimen.

The results on polyvinyl chloride, polyvinyl 87-chloride 13-acetate and polystyrene, materials which sorb little or no water, indicate the validity of Fick's law for materials of this type in that practically the same constant is obtained regardless of the humidity range used in the test. Polymethyl methacrylate and polyethylene sebacate, which sorb less than 2 percent of water at saturation, illustrate a slight departure from the law. For materials that sorb considerable water, such as polyvinyl acetate, polyamide (6–6) and most cellulose derivatives, various diffusion values are obtained which differ too widely to be expressed by an average value. G. J. Brabander[4] reports data in which the permeability of water vapor (gm./sq. m./24 hr.) through lacquered glassine paper increased almost 100 fold when the vapor pressures are changed from (9.4–0.0) to (18.8–9.4) mm. Hg. The results on polyamide are almost of this order and a modification of Fick's law to include the effect of water sorption is necessary. The arbitrary selection of any given humidity range and comparison of all data on the basis of Fick's law otherwise would be misleading in the case of moisture sorbing systems.

The effect of moisture content on the rate of diffusion is more clearly indicated in Fig. 3. In these curves the water contents at the vapor pressures indicated in the column headings of Table VII are figured from equilibrium sorption data assuming linear vapor pressure gradient across specimen.

It is not the intention of the foregoing to present complete engineering data on the materials tested nor to pass on their

[3] E. Badum, Kautschuk *12*, 231 (1936).

[4] G. J. Brabander, Paper Trade J. *108*, No. 4, 39 (1939).

TABLE VII.—VARIATION OF THE DIFFUSION CONSTANT WITH RELATIVE HUMIDITY AT 25° C.

| | Vapor pressure conditions | | | | |
|---|---|---|---|---|---|
| *In cell, $p_1$* | *0.25* | *0.25* | *23.75* | *23.75* | *23.75* |
| *Outside cell, $p_2$* | *10.17* | *21.02* | *00.25* | *10.17* | *21.02* |
| *Differential* | *9.92* | *20.77* | *23.50* | *13.58* | *2.73* |
| ***Material*** | Diffusion constant ($D \times 10^{-8}$) | | | | |
| Polyethylene sebacate, cast | 5.89 | 6.50 | 7.69 | ... | ... |
| Polyamide (6–6 Du Pont) | 1.45 | 4.08 | 11.30[a] | ... | ... |
| Polyamide (6–6 Du Pont) | ... | ... | 11.03[a] | 18.5 | 70.3 |
| Polyvinyl chloride, molded | ... | ... | 0.46[a] | 0.46 | ... |
| Polyvinyl 87-chloride 13-acetate, molded | ... | ... | 1.12[a] | ... | 1.24 |
| Polyvinyl acetate, molded | ... | ... | 29.9 | 41.7 | 85.0 |
| Butvar 25/95, molded | ... | ... | 6.43[a] | 7.11 | 12.54 |
| Cellulose acetate A-17, acetone cast | ... | ... | 287.0 | 433.0[b] | ... |
| Cellulose acetate A-17, acetone cast | ... | ... | 310.0 | 458.0[b] | ... |
| Cellulose triacetate, molded | 50.7 | 58.5 | 71.2[a] | 91.0 | ... |
| Cellulose acetate butyrate, molded | ... | ... | 52.2 | 59.2 | 97.6 |
| Cellulose acetate propionate, molded | ... | ... | 101.8 | 123.0 | 250.0 |
| Ethyl cellulose, molded | ... | ... | 76.8[a] | 99.5 | 151.0 |
| Polystyrene, molded | ... | ... | 3.50 | 3.29 | 3.69 |
| Polystyrene, molded | 3.67 | 3.55 | ... | ... | ... |
| Polymethyl methacrylate A, molded | ... | ... | 4.07[a] | | 5.33 |
| Polymethyl methacrylate B, molded | ... | ... | 4.01[a] | | 5.85 |
| Ethyl cellulose (plasticized), molded | ... | ... | 16.02[a] | | 26.5 |

[a] Phosphorus pentoxide instead of calcium chloride; $p_1 - p_2 = 23.75$.
[b] $p_1 - p_2 = 23.75 - 11.88 = 11.87$.

relative merits for any particular application. The choice of specimen thickness and other factors must be determined by the design under consideration and where it is to be used. In addition, many plastics are available in a wide variety of formulations, permitting the engineer substantial latitude in choice of materials.

### Acknowledgment

Acknowledgment is made to Mr. W. J. Clarke of the Bell Telephone Laboratories, Inc., for his part in this work.

# Industry expansion

(*Continued from page 102*) unanimous "Yes." Still another development which seems likely to become a factor of some importance is the successful experience of several molders with zinc base alloy as a substitute for die steel in molds, to facilitate cheaper production for small quantities of parts.

### The laminating industry

The production record and growth of the laminating industry has been just as amazing as that of the molding industry, and its future seems likely to be even more brilliant.

There were 37 laminators on record in 1940, but 14 of them were fringe operators who participated in the laminating business in a very small way or owned a small amount of equipment which they operated as a part of some other business. There were only 15 who used as much as 100,000 lb. of laminating varnish per month.

Today there are 30 laminators who are allocated over 100,000 lb. of varnish per month. There are few newcomers in this list, the increase from 15 to 30 consisting mainly of those who were on the fringe prior to 1940. These figures do *not* include low-pressure or contact-pressure laminators, because it is impossible at this time to get accurate statistics on this comparatively new branch of the laminating industry.

The amounts of finished laminates produced in the years 1940 to 1943 by all the companies listed above are shown in Fig. 4. The industry's dollar volume has risen from a little less than $15,000,000 in 1939 to about $80,000,000 in 1943.

This growth has not been accompanied by a comparable increase in plant size and equipment because the industry was well prepared to assume its war role—a fact which accounted for its phenomenal increase in production. The bulk of its equipment was comparatively new and modern, and since it required no extensive retooling, its transitional headaches were those of manpower involved in jumping operations from one shift to three a day.

The new equipment which has been installed since 1939 has not been revolutionary in itself, but it has enabled the industry to make bigger things and make them better and faster. As one laminator explained in discussing his company's position, new equipment simply rounded out production requirements such as tubes in longer lengths and larger diameters, more special grades than ever before, greatly improved and expanded control and laboratory work.

The greatest expansion in laminating plants took place in their fabricating rather than their raw materials departments. The reasons for this were two:

1. Laminators' customers were eager to sub-contract all possible work to companies that could fabricate the materials they themselves produced. As a result, the laminator expanded his fabricating facilities so that he could produce more finished parts rather than sheets, rods and tubes.

2. Fabricating laminates requires a different technique than machining metals or other materials. Very few prime contractors were prepared to machine sheets, rods and tubes made of laminated materials on such a huge scale as war contracts involved. If they made mistakes or damaged material through faulty machining, they suffered a financial loss. Consequently they preferred to have laminators do the machining job and deliver finished pieces only.

It is presumed that laminators will continue to maintain this grasp on the fabricating end of their business and thus increase their dollar volume over prewar days.

Greatly expanded demand for high-pressure laminates, after the war business is completed, is expected to come from the rapidly growing electronics industry where laminates have proved their superior qualities for electrical insulating parts that require the unique combination of electrical, mechanical and chemical properties offered by the many available grades and types of laminated products.

One major source of growth, during the prewar 1930's was textile equipment where laminated parts had proved particularly adaptable, especially in rayon mills. Tons of corrosive chemicals are used in synthetic textile production, and laminates filled the need for materials that would withstand chemical and corrosive reaction. Examples are molded laminated spinning buckets, bobbins and machine parts.

In addition to new and expanded uses for old-type laminates there are several new war-born materials that will undoubtedly expand the potentialties of laminates. Such things as felted asbestos material, felted cotton material, woven glass and glass textiles, low-pressure resins, melamine resins and contact resins offer room for a host of new applications that will find new uses in the postwar industrial pattern.

In addition to these new materials, such new techniques as postforming of cured laminates, new treatments of wood, low-pressure laminating, contact laminating and high-frequency heating present unforeseeable possibilities. No one in his senses would attempt to predict how far they will go. The only certain factor is that they are now in their infancy and some of them are right lusty babies with every prospect for rapid and healthy growth. Their possibilities in such fields as furniture, freight cars, boats and structural board are tremendous, but they are still behind the curtain so far as the general public is concerned. It is significant that raw materials companies never before in the plastics industry are making plans to tap this potential field with such items as impregnated paper and fabrics. Any gigantic development in these new lines, however, is at least several years away both because of lack of sufficient capacity and because the industrial engineering fraternity is not yet familiar with their properties and their limitations.

The industry's big stake immediately after the war lies, as it always has, in the electrical, industrial, automotive and decorative laminate fields. As these industries return to civilian production they will find the laminators ready to deliver any required amount of production and in a variety of grades and materials not hitherto available. There will be no reconversion problem such as that of junking present machinery and starting all over along new lines because there was no character-altering change in the industry when its production was called to war.

### Facing the future

The conclusions which can be drawn from this study augur well for the industry's ability to fill its postwar orders. The thermosetting branch has sufficient facilities to handle the

demand for plastics moldings that may follow immediately after the war. Facilities in the thermoplastics branch are tight, but are—or soon will be—capable of taking care of all raw material production immediately in sight. The long range view in thermoplastics is a little murky because of the styrene situation, but it is believed that when component parts and metal are available, machinery production, particularly in large sizes, will keep pace with raw material production. The laminators are well equipped not only to turn out their materials in needed quantities but to fabricate them.

Certainly buyers and users of the millions of plastic pieces which become components of their manufactured products may safely cast aside any fears they may have harbored that the plastics industry will be incapable of handling their postwar requirements.

### Acknowledgments

MODERN PLASTICS acknowledges with thanks the assistance given in the preparation of this article by the processors of plastics who so kindly filled out questionnaires, by the raw materials and machinery manufacturers who supplied facts and figures, and by numerous members of the Plastics Branch of the WPB who gave generously of their time and of their information.

# Rocket launching tubes

(*Continued from page 129*) untreated paper. A paddle is used to spread out this resin so that it forms a lake on the paper just before it enters the rolls. Figure 4 clearly indicates this operation. The flow of resin is controlled by a valve on the right of the feed pipe, and large overhead tanks serve as a reservoir so that at all times during the rolling operation the paper is drawn through a lake of resin which completely impregnates it just prior to rolling. Any surplus or excess resin runs off both outside edges of the paper. An ingenious gutter system traps this excess resin and feeds it into storage cans so that it may be reused. After approximately 80 to 90 turns of the mandrel, the resin impregnated paper tube has a wall section of approximately $^1/_4$ inch. This variation in the number of turns that are necessary is caused by a variation in the thickness of the paper. The tolerance in this paper thickness allows for a variation of $\pm$ 0.0005 in paper with a thickness of 0.004.

**8**—***After painting the tubes are assembled in a cluster of three and equipped with rocket holding clamps, firing contacts, electrical wiring and mounting brackets***

OFFICIAL PHOTO, U. S. SIGNAL CORPS

From 11 to 12 ft. of impregnated paper can be rolled per minute, and the time necessary for rolling each tube is approximately 10 minutes. Inasmuch as there are 48 tube rolling machines in operation, the production of this plant is in excess of 5000 tubes per day. After a tube has been rolled to the required thickness, the paper feed is cut, pressure rollers raised, and the mandrel and tube removed from the machine and placed on the conveyor by an electric hoist. The tube and mandrel are then moved to the entrance of a large curing oven, hung vertically on another overhead conveyor and passed through the oven. Each mandrel and tube remains in the oven about $6^1/_2$ hours. The temperature of the oven is 105° C. over most of its length. The final stage in this oven involves the cooling of the tube and mandrel which tends to set the material so that immediately upon removal from the oven it is hard and in condition for the next operation—removal of the mandrel from inside the tube.

Figure 5 shows five tubes mounted on the frame that carried them through the oven. When the mandrels and tubes emerge from the oven, this frame is turned so that the mandrels and tubes lie in a horizontal position rather than hanging vertically. Then the frame is pushed along a conveyor to a position in front of an electric hoist. The hoist removes the tubes and mandrels from the frame and places them in position on the tube stripper shown in Fig. 6. This hydraulic stripping device grasps one end of the mandrel which has been inserted in a hole with a diameter large enough to permit passage of the mandrel, but small enough to hold back the rolled tube. Pressure is applied to the hydraulic ram, and the mandrel is forcibly withdrawn, leaving a perfectly smooth mold finish on the inside of the tube.

The outside of the tube is still very rough and has loose ends of paper adhering to it. Since its O.D. is still not to the required tolerances, the next operation is centerless grinding. When completed, this grinding will leave the tube with a fine finish on the outside and an O.D. of the required size. In this operation, two lines of six centerless grinders each are used. Each of the six grinders in a line is set to grind diameters progressively smaller by 0.010 inch. The tubes are fed by hand along a conveyor to the first of the grinders. While all tubes are not enough oversize to be cut in the first two or three units, these three extra grinders which are set up for the greatly oversized tubes have been found to prolong the life and make for more accurate setting of the final finished cut grinders at the end of the line. Figure 7 shows a part of this grinding line. The grinder in the foreground is next to the last in the line; the final cut unit is positioned behind this grinder. A continuous stream of water is fed to the grinding wheels and serves not only to keep the ground work from becoming hot but to carry away the excess material that has been ground off.

Having been ground to size in the O.D., the tubes are then placed between two saws which are so adjusted that the tubes are cut to a length of 10 in. + $^1/_8$ in. −0. These saws are 18 in. disk saws and rotate at 3300 r.p.m.

Next, holes must be drilled in the tube to permit the assembly of the device used to hold the rocket in the tube, to allow the installation of the electrical firing equipment and to permit the assembly of the tubes into a cluster. Each cluster is made up of three tubes so assembled and wired that the pilot of the plane can fire one rocket at a time or three in a salvo.

The plant is now in the process of switching its method of assembling the three tubes. Up until this time, a phenolic axial block was used to locate the tubes in position with

relation to each other, after which the tubes were merely glued together along their points of contact. This method was fairly satisfactory but not entirely so. For this reason, the phenolic blocks were replaced with magnesium blocks which had previously been drilled and tapped. Holes are drilled through the end of each tube to match the hole in the block; they are countersunk from the inside so as to permit a screw-head to assemble flush or slightly below the surface of the inside of the tube. Each tube is attached at both ends to the axial block by means of a screw—thus achieving a solid and permanent assembly of the cluster.

The tubes are then conveyed to the painting section where they are sprayed on the outside with the proper color. This paint is quickly made dust-free by means of a bank of infrared lamps. Next comes the assembly of the rocket holding clamps, the firing contacts, electrical wiring, mounting brackets and like attachments. All these operations are done on a moving production line. The cluster (which is now ready to be mounted under the wing of a fighter) is immediately packed in a box, rolled along the conveyor and placed in a freight car for shipment. Figure 8 shows the cluster just before it is placed in the packing box.

Once again, plastics have come through in time to fill the breach and helped to make possible the destruction which is officially credited to the rocket-firing tank-busting Thunderbolts. A recent official estimate gave the P-47s credit for the destruction of 10,000 tanks and trucks, for the creation of tremendous confusion and chaos among retreating enemy troops. In releasing information on the successful development of these rocket launching tubes, the molding company expressed appreciation for the cooperation of Capt. J. J. McNiff, Resident Officer for Boston Ordnance District under command of Col. H. B. Sheets.

*Credits—Material: Textolite. Molded by General Electric Co., Plastics Divisions. Machinery built by E. W. Bliss Co. and Baldwin-Southwark Div., Baldwin Locomotive Works*

# Transfer mold design

(***Continued from page 140***) and molding parts with a gradually increasing load to show the various "flow" and "fill out" stages. Knit points and positions where gas is entrapped will show up in this experimental run.

Inserts used in transfer molding must be anchored tightly on the mold pins. The knurled insert surface may engage the entering ribbon of compound and be forced into rotation so that it moves out of position on the pin. This may require a very tight fit on the mold pin and a retapping operation after molding. An annular pin may help by making use of a holding fit on the O.D. of the insert. When plastics materials are molded into the inside of a metal tube, all cavities must be fed from the same chamber to prevent bursting of the inserts. An excess charge in any one chamber of a multiple chamber mold would produce a bursting pressure in the insert that it feeds. Through inserts may be made a few thousandths over size in length so that they crush slightly when the mold closes. This will keep the exposed faces clean and it may be done safely when soft metals are used for the inserts.

It is possible to use excessive pressure in transfer molding. This condition will be indicated by pieces that are larger than the mold dimension, especially in the build-up dimension. Molded pieces have been found to be compressed by an excessive molding pressure so that they will spring back after the pressure is released.

Considerable care must be exercised in the design of transfer molds for the melamine-formaldehyde compounds. Such molds must have adequate and uniform heating systems. Venting and the elimination of knit lines are most important because any lack of density or failure to knit will show up as an electrical weakness. Difficulty may be experienced with the transfer molding of one-stage resins since they tend to heat and set up whereas the two-stage resins will flow nicely after a considerable amount of preheating.

Basic consideration in mold design are as follows: available press or presses, size and number of cavities, material to be molded (compound), pressure required for compound, loading of inserts, ease in removal of molded part, number of parts to be produced, reduction of finishing operations to a minimum, available preheating methods, mold heating requirments, size of "transfer" chamber, type of sprue puller desired, position of knockouts, location and size of gates, location and size of runners and location of vents.

# In step with fashion

(***Continued from page 115***) sections, the plane of division of said mold sections being in a plane oblique to the axis of the mold, one of the mold sections having an elongated tapered cavity therein; the oblique end of the complementary section having a raised plate, means for supporting a heel-shaped core within said cavity in uniform spaced relation from certain wall portions thereof and with an end of the core against said raised plate; a horseshoe shaped fluid conducting channel formed on the oblique face of the complementary mold section; a plurality of spaced feeding ducts in said face of the same section affording separate fluid communications between selected portions of said channel and spaced portions of the mold cavity; and a fluid inlet duct extending into the mold and registering with an intermediate portion of said channel.

3. A permanent mold, comprising a pair of endwise separable, complementary mold sections, the plane of division of said mold sections being oblique to the axis of the mold, one of the mold sections having an elongated tapered cavity therein and the other having a face portion closing an end of the cavity; means for supporting a heel-shaped core within said cavity in spaced relation from certain wall portions thereof and against said face portion; a curved fluid conducting channel formed in said face portion; a plurality of spaced feeding ducts in the same face portion affording separate fluid communications between selected portions of said channel and spaced portions of the mold cavity; and a fluid inlet duct extending into the mold and registering with an intermediate portion of said channel.

*Credits—Material: Lumarith, Plastacele and Tenite. Heels molded by Pereles Bros., Inc.*

# Thermo-elastic forming

(***Continued from page 135***) die is shown in Fig. 6. The part formed in this die is a flanged and beaded dome light bracket. A finished part is shown resting on guide pins in the die. The operator places the softened material, cut to the shape of the flat pattern shown in the lower left-hand corner of Fig. 6, on the guide or locating pins and brings the plunger in contact with the spring-loaded floating portion of the die, which is locked in position. At this stage the plunger compresses the blank down between two parallel spacers, whereupon the lower flanges are turned up. The lock is released

TABLE I.—HEAT-FORMING SPECIFICATIONS FOR 1/16-IN. THICK MATERIAL[a]

| Heating period | Temperature of oven |
|---|---|
| *min.* | *° F.* |
| 2.75–3.0 | 350 |
| 2.0 –2.25 | 400 |
| 1.0 –1.20 | 450 |
| 0.9 –1.00 | 500 |

[a] Reference, North American Specification NA2-4141.

TABLE II.—HEAT-FORMING SPECIFICATIONS FOR VARIOUS THICKNESSES OF MATERIAL[a]

| Material thickness | Heating period | Minimum 90° bend radius[b] |
|---|---|---|
| *in.* | *min.* | |
| 1/16 | 0.9–1.0 | 1/8 |
| 3/32 | 1.2–1.5 | 1/4 |
| 1/8 | 1.3–1.7 | 3/8 |
| 3/16 | 1.5–2.0 | 5/8 |
| 1/4 | 3.5–4.0 | 1 |

[a] Reference, North American Specification NA2-4141.
[b] Average conditions for most fabric base laminates.

and the plunger, along with the floating plate on which is hinged cam-actuating pressure members, continues downward until the bottom stop is reached. The stationary cams exert increasing lateral pressure on the hinged members during the second stage until the vertical beads and upper right-angle flanges are formed. Figure 7 features a three-stage, semi-automatic die. This die operates in much the same manner as the two-stage die operates, except that the lateral compression members are closed by the operator and then compressed by the plunger which provides the cam action. The formed ejection chute, which is produced from this die, is shown in position on the stationary core.

Frequently, large parts require special presses and dies such as the ammunition guide chute noted in Fig. 8. The chute is 7 1/2 ft. long and has longitudinal beaded C-shape flanges. One end of the chute is bell shaped to accommodate non-restricted passage of ammunition to the machine gun. The die is two-stage operated, that is, the beads in the bottom are impressed first, followed by progressive bending of the beaded flanges.

Fabricating formed parts entails no special equipment or training. Conventional tools suffice for riveting, machining and assembling of components. Figure 9 depicts a typical drill jig assembly for a formed ammunition-ejection hopper.

### Procedure and specification

To form thermosetting materials successfully, the optimum plasticity must be obtained. This is done by heating the blank in a suitably heated medium. A gas-heated oven having forced circulation of air is found to be most satisfactory. Other methods worthy of mention are: 1) infrared ray lamps, 2) oil bath, 3) live steam, 4) heatronic, 5) hot platen.

The rate at which the material becomes plastic is directly proportional to the temperature differential between the unheated material and the heating medium.

A desirable feature of this process is that it does not necessitate expensive and time consuming equipment such as steel dies or the excessive heat and pressure that are so necessary for high-pressure molded parts.

The forming pressures required are relatively low. They range from 10 to only 100 p.s.i., depending upon the depth of the part, thickness of the material and construction of the forming die. For this purpose, inexpensive dies may be constructed of wood, especially hard wood. Wooden dies are entirely satisfactory for parts that exact only a minimum amount of bending and complex curing. For difficult parts, wooden dies may be reinforced at points of stress by means of metal inserts.

The pressure may be applied by any number of devices. Hydraulic presses, screw-jack press, toggle press, etc., are satisfactory. The dies for parts requiring minimum amounts of pressure can be actuated by means of eccentric cam levers, toggle action or a combination thereof.

In general, spring-back is not very troublesome. However, it presents more of a problem in some parts than it does in others, depending upon the design. The amount of spring-back depends upon the following six factors: 1) material, 2) material thickness, 3) temperature of heating medium, 4) length of time the material is heated, 5) bend radii and degree of bend, 6) length of time part remains in die.

There is no specific solution available to counteract spring-back for all types of material. Since some materials are less stable than others, they require more attention to detail characteristics. If spring-back is prominent, the die may be constructed with proper tolerance to alleviate it.

## By their lines

**(*Continued from page 121*)** texture. Instead of using optical polishes to make things even more like mirrors, couldn't we do the opposite and sandblast molds, giving them a natural roughness which would greatly add to the finish of any object? Or, perhaps even better, couldn't we develop some processes by which we would have both highly polished and matte areas, making the surface itself into a pattern of light and shade, and even changing hues—a technique used so successfully in mosaics even if the medium there is of a different nature? Texture like this would be a new thing.

Then too, texture could add greatly to function itself. Just as every machinist knows that a knob with a knurled edge is designed to be turned by hand, plastic parts which are designed for release or movement by hand could and should have rough or patterned planes for better gripping. Some plastic caps have lines for that purpose now. But in most cases basic design as well as appearance could be much improved, if knurls—and there are many variations of knurls—roughened surface or definite indentations were to be incorporated into the molds.

And there is another thing. We have seen such marvelous developments in plastics of all kinds that most of us still stare in wonder and stupefaction when we look at some of the color libraries at hand. "For goodness sake," we exclaim, "this looks like marble. Black marble, pink marble, green marble. How fantastic."

And we probably haven't "begun to fight." We'll have better and finer formulae as time goes on and the alchemists' wildest dreams will sound like baby talk. We will make bigger and better molds at lesser cost, and finer presses which mold ever faster. Molding cycles will get shorter and shorter.

But still, with all this, we have accomplished little for better living. Our feet have not yet quite grown to the size of our shoes. Our minds do not yet seem attuned to the real miracle of a material which challenges every phase of living.

Basic human needs do not change. They increase, perhaps, and become more diversified. Yet, somewhere, as science advances and discovers new techniques and new applications, the tasks of living might become easier and daily duties less exacting. And so where neither wood nor metal

nor stone will serve, plastics might. Where glass is no longer practical and a natural fiber has exhausted its usefulness, plastics come in.

So, when it comes down to the final point, what we really need is a new and basic kind of thinking—a philosophy, perhaps—no longer based on things as they were but on the new methods of a new day. A new theory of design above all. Not one derived from the lessons of the past which were applied in so large a measure to materials then known, but one born of the need for new form and new decoration—and new texture—inherent in a new matter.

# Portable hangar

**(*Continued from page 109*)** the company to turn out 12,500 yd. of 36-in. material in one day.

Since speed in erection is of great importance, the canvas is divided into easily handled sections. Thus, a total of 21 panels are employed to cover the front, back and roof of the hangar. The front curtain is made in 6 panels; the back curtain in 6 panels; the front gable in 3 sections; the rear gable in 3 sections; and the roof in 3 panels. It is estimated that even with unskilled workers the structure can be completely assembled in one day.

A variety of lightweight canvas socks are necessary to provide a tight seal around the openings in the canvas end curtains where a plane's motors and fuselage project into the hangar. Nine identical motor socks are furnished with each unit. These socks are 8 ft. 6 in. square, slit at the bottom and equipped with a draw string for tightening the canvas around the nacelle. The sides of the sock lace to the grommet strip on the inside of the curtain. Similar in design and operation are the socks for the fuselage. However, for these pieces four different sizes are necessary.

After the canvas, which is supplied by the Navy, is impregnated and processed for both tropic and arctic climates, it is shipped to various points in the United States for fabrication and assembly. At the same time but at another point in the country, the steel framework is similarly prepared for shipment. Finally, both start for the same destination.

*Credits—Material: resin and window sheeting, Vinylite. Canvas processed by Textileather Co. Coverings fabricated by Newcastle Products Co. and its subcontractors. Steel frame by International Derrick & Equipment Div., International-Stacey Corp., and Milwaukee Iron Works. Hangars for U. S. Navy*

# Oxygen demand valve

**(*Continued from page 111*)** servicing. The Canadian Aircraft Instruments and Accessories, Ltd., assisted in the production engineering and are now manufacturing these valves. The results according to Wing Commander J. K. W. Ferguson, Medical Officer in Charge, #1 Clinical Investigation Unit, R.C.A.F., show that: "Canadians can make precision parts better than anything the Germans have done in this field."

Figure 1 shows the current model to be compact and light enough so that it may be worn on the airman's clothing. It is surprising to note that the complete unit including all the automatic features weighs only 14 oz., and this is said to be considerably less than any other demand valve available. In addition, it is said that the present unit is far more efficient than the latest available German model.

The largest and possibly the most complex component part of the valve is the demand valve body (Figs. 3 and 4). The choice of material for this valve body was based on the necessity of having lightweight, good strength characteristics, close tolerances, mechanical and chemical stability, commercial-scale production and cost that was not prohibitive. Woodflour-filled phenolic molded plastics were chosen as having the greatest number of desirable qualities. The use of this plastic made it possible to mold the body in one operation, reduce additional machining operations to a minimum, hold the required close tolerances, produce the part in the needed quantities and avoid the need for a protective coating.

Figure 3 shows the three main stages of development of the valve body in plastics after brass and aluminum models had been tried. In the final design full advantage is taken of the molding process to provide curved surfaces for greater strength, reduce projections to a minimum, and incorporate a great number of molded threads, thus saving additional machining.

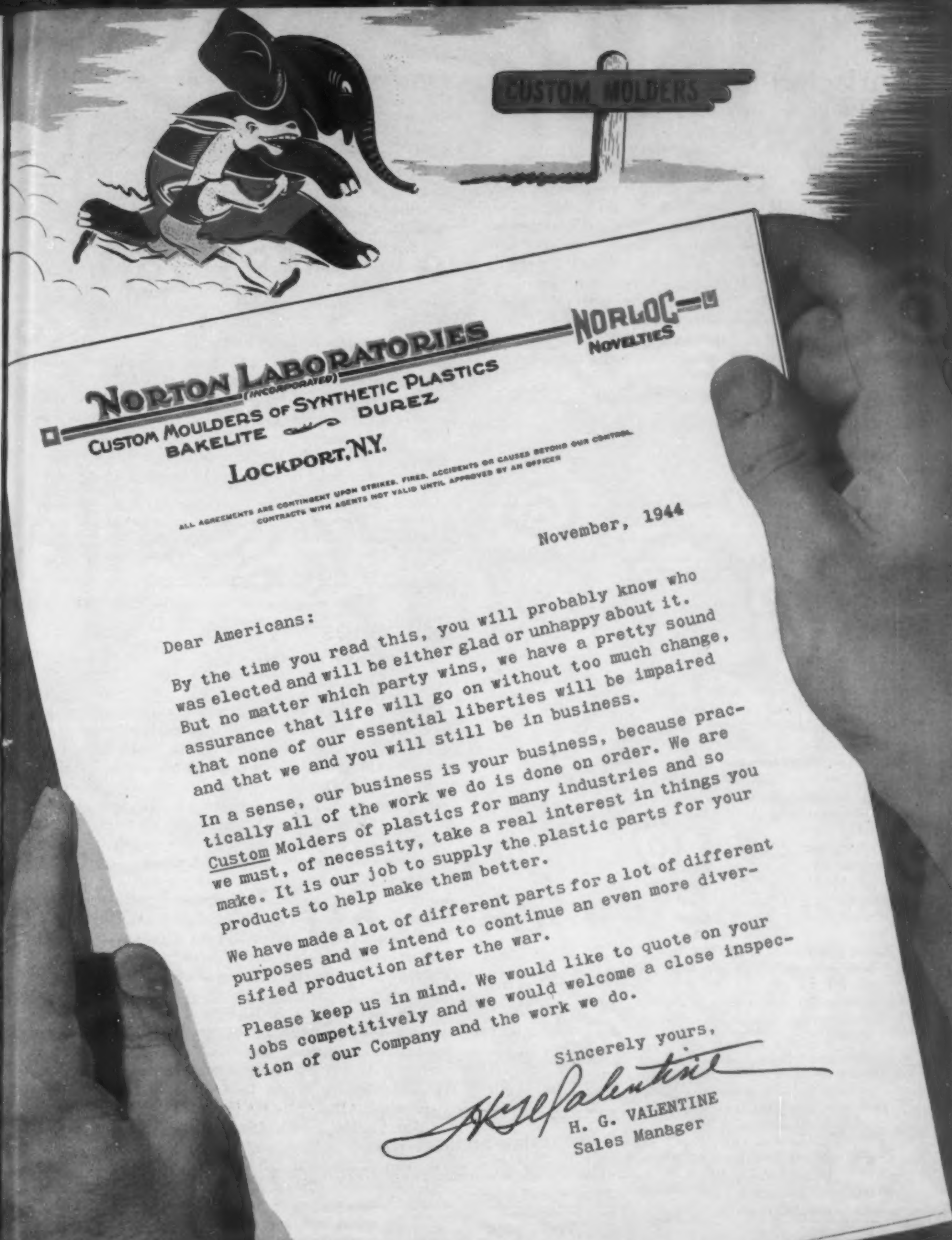
Even from a superficial study of the drawing of the present valve body in Fig. 2, the molding problem can be appreciated. Thin and heavy sections are molded in one piece, presenting a serious problem in warpage. Tolerances are exceptionally close and difficult to maintain. Seven different sized threaded holes in three planes on the part are molded in one operation and to a Class 2 fit. The specifications for all complementary parts call for a Class 2 fit, eliminating costly subsequent operations. The out-of-round condition of the threaded holes is a matter demanding continuous attention since a tolerance of only 0.005 in. is allowable.

Pins screwed in from the side of the mold form all threads with the exception of the 0.625-in. diameter 26 T.P.I. which is formed by a separate pin mounted in the mold itself. This pin is left in the molding after the completion of the molding cycle to maintain the concentricity with the 0.187-in. diameter hole. The 1.250-in. 26 T.P.I., the 1.000-in. 26 T.P.I. and the 0.750-in. 26 T.P.I. threaded holes are molded by one pin. Of necessity the pin in the 1.344-in. dimension (see Section A-A, Fig. 2) must extend without support with a maximum of 0.625 in. diameter.

Sixteen tapped holes around the 3.420-in. diameter are marked in the molding operation, and drilled and tapped later. Inspection is so rigorous that even a small crack across the approximately $^1/_{32}$-in. space between the edge of one of these tiny tapped holes and the 3.420-in. diameter is sufficient cause for rejection. Another interesting feature of the design is the incorporation of a small bead on the 3.420-in. diameter pitch circle. This bead is actually semicircular in profile, being 0.007 in. in height and 0.014 in. across. It serves the sole purpose of causing a seal to the complementary rubber gasket without the use of a sealing cement and uses the principle of concentration of pressure on a small area. Designed carefully so that the plastic bead does not cut into the rubber gasket but makes a secure and permanent seal, it eliminates all possibility of air leakage into the valve proper.

The molding job, strict as it is, would have been further complicated had not a high flow woodflour-filled phenolic been used. This is because all threads must be filled out perfectly with compound—the plastic flowing around and under the pins in the process. Pressure is held to 2000 to 2500 p.s.i. Mold temperature is 320° F. and cure takes 5 minutes.

*Credits—Material: Bakelite. Present valve body molded by Canadian General Electric Co., Ltd.; two previous models by Smith and Stone, Ltd. Complete valve designed and produced by Canadian Aircraft Instruments and Accessories, Ltd., for Royal Canadian Air Force*




NORTON LABORATORIES
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CUSTOM MOULDERS OF SYNTHETIC PLASTICS
BAKELITE DUREZ
LOCKPORT, N.Y.

NORLOC NOVELTIES

ALL AGREEMENTS ARE CONTINGENT UPON STRIKES, FIRES, ACCIDENTS OR CAUSES BEYOND OUR CONTROL
CONTRACTS WITH AGENTS NOT VALID UNTIL APPROVED BY AN OFFICER

November, 1944

Dear Americans:

By the time you read this, you will probably know who was elected and will be either glad or unhappy about it. But no matter which party wins, we have a pretty sound assurance that life will go on without too much change, that none of our essential liberties will be impaired and that we and you will still be in business.

In a sense, our business is your business, because practically all of the work we do is done on order. We are Custom Molders of plastics for many industries and so we must, of necessity, take a real interest in things you make. It is our job to supply the plastic parts for your products to help make them better.

We have made a lot of different parts for a lot of different purposes and we intend to continue an even more diversified production after the war.

Please keep us in mind. We would like to quote on your jobs competitively and we would welcome a close inspection of our Company and the work we do.

Sincerely yours,

H. G. Valentine

H. G. VALENTINE
Sales Manager

# Surfacing for plywood

(*Continued from page 118*) spoil the contents. To meet the problem, a box was designed of plastic surfaced Douglas fir plywood, $^5/_8$-in. thick, exterior type.

Before adoption by Army Ordnance the box was fully tested at Forest Products Laboratory. It successfully passed a very severe test in the tumbling drum, fully loaded. After being tested in the tumbling drum the box was immersed in water for 24 hours. Weighing before surface water had evaporated revealed a moisture pick-up of less than 1 percent.

The nested boxes[1] shown in Fig. 3 have proved themselves in many landings. The fact that they can be reused as cases in which to pack damaged parts that must go to a rear position for repair is not the least of their advantages. Wooden packing cases, in contrast, are so torn apart by the time they are unpacked that their reuse value is negligible.

[1] Inderon in the plastic surfaced plywood used in these boxes.

TABLE I.—PROPERTIES OF PHENOLIC RESIN IMPREGNATED SURFACING

| | |
|---|---|
| General properties: | |
| Colors | Now furnished only in olive-drab and black. Other colors available postwar |
| Surface finish | Glossy, satin and matte (for painting) |
| Aging characteristics | Stable on interior uses |
| Weatherability | Slight fading under prolonged exposure, when phenolic resins are used |
| Flammability | Moderate ignition |
| Weight | Standard grade—60 lb. per 1000 sq. ft.; 0.009-in. film thickness |
| Effect of wet steam | None |
| Effect of cold | None |
| Abrasion | Highly resistant wet or dry |
| Chemical stability, resistance to: | |
| Weak inorganic acids | Excellent |
| Weak inorganic alkalies | Excellent |
| Weak organic acids | Excellent |
| Alcohols | Excellent |
| Hydrocarbons | Excellent |
| Mineral oils | Excellent |
| Vegetable oils | Excellent |
| Acetones | Good |
| Ketones | Good |
| Esters | Good |
| Physical properties of Grade 2000: | |
| Tensile strength, | |
| parallel, p.s.i. | 18,000 |
| cross, p.s.i. | 14,000 |
| Elastic modulus (tensile), | |
| parallel, p.s.i. | 1,650,000 |
| cross, p.s.i. | 1,200,000 |
| Flexural strength, parallel, laminated machine direction, p.s.i. | 16,000 |
| Izod impact, flatwise, ft.-lb./in. notch | 1.9 |
| Flexural modulus, parallel laminated, machine direction, p.s.i. | 1,470,000 |
| Water absorption,* 24 hr. A.S.T.M., percent | 0.4–1.85 |
| Water permeability,* 30 mile wind, percent | 0.94–1.26 on exposed area |
| Vapor permeability,* gr./sq. in./hr. | 0.164 |
| Abrasion (KC tester), | |
| dry | 0.07 loss |
| wet, gr./sq. ft./hr. | No measurable loss |

* Based on $^5/_8$-in. 3-ply Douglas fir plywood exterior grade.

For years Douglas fir plywood has been used as an inexpensive structural material. The pronounced tendency toward surface checking and grain raising of this type of plywood in service, even though well painted, has prevented its adoption for many uses for which it was otherwise entirely acceptable. Plastic surfacing, even in the minimum film thickness of 0.009 in., eliminates the surface checking and minimizes the tendency to grain raising. In this sense it makes Douglas fir plywood a more stable product.

It should not be construed that this plastic surfacing in its present stage of development is a universal surfacing material of ideal qualities. Research by the developing company is continually improving the material and the techniques for its application. While the material in its present form must be cured under the action of heat and pressure, the development of a precured type of plastic surfacing in roll form may be a reality in the future.

Developments already in process anticipate grades of this material that will bridge blemishes and gaps in the base material. In the case of plywood this will permit greater wood utilization through the medium of upgrading veneers that have been classified as off-grade on an appearance basis only.

*Credits—Material: Kimpreg. Shipping case MK-1 fabricated by American Furnace Co. Four-in-one box and armament spare parts box fabricated by American Furnace Co., Moline Pressed Steel Co., The Modern Box Co., Herkert & Meisel Trunk Co.*

# Silicones

(*Continued from page 126*)

## HTS insulation

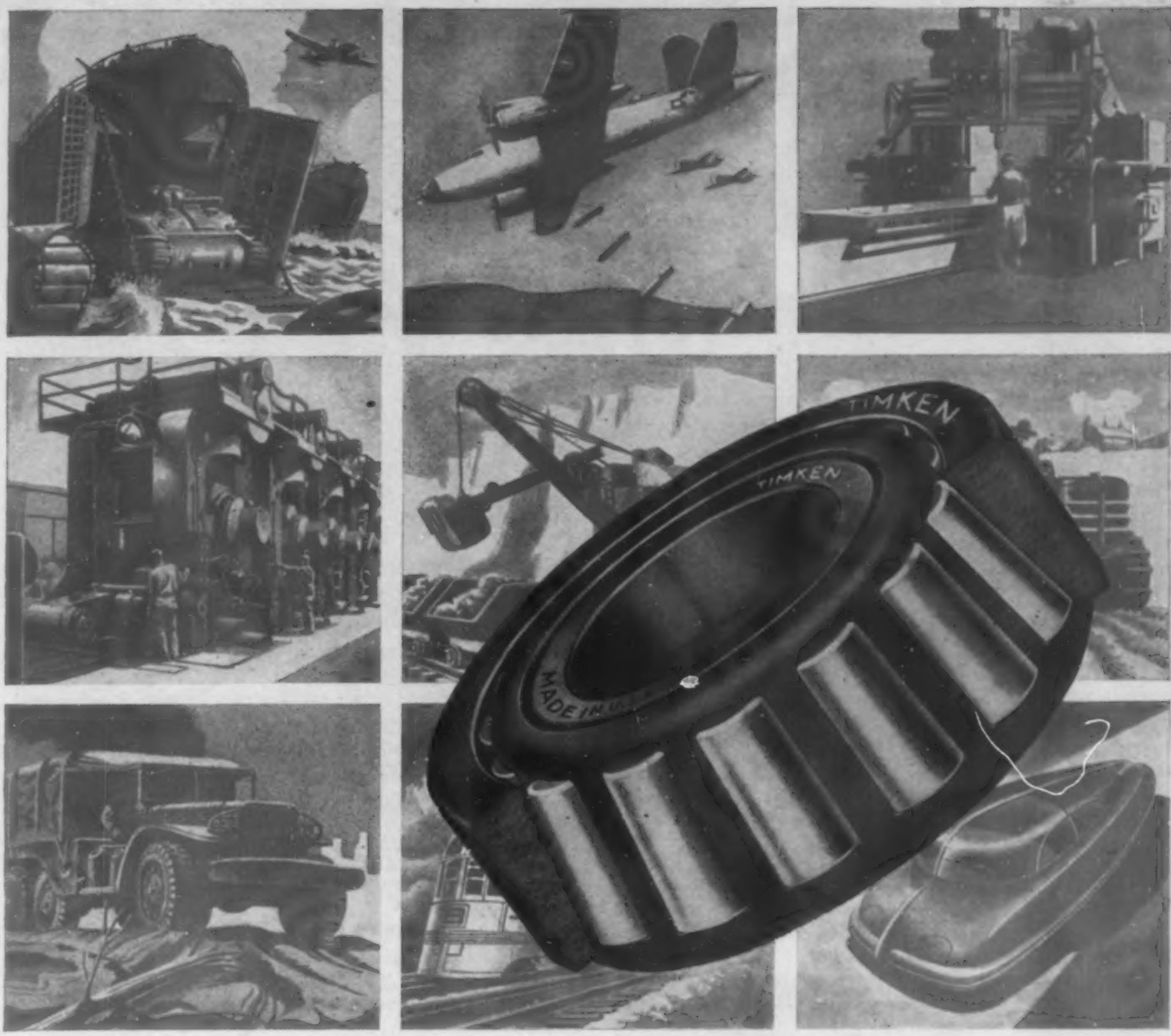
In order to take full advantage of the heat resistance of the new silicone insulating resins, electrical equipment should be designed to eliminate all organic materials. Figure 4 illustrates an example of this type of construction in a typical stator slot. Glass fiber served magnet wire is impregnated with silicone resin and cured in conventional wire enameling towers. The silicone resin fills the voids between the glass fiber yarns and permits the production of a smooth continuous insulation which is heat stable and waterproof.

Silicone varnished glass-fiber cloth provides a backing to which mica splittings can be laminated by silicones as adhesives to produce ground insulation for lining the slot cell. Heat-resistant coil separators and slot sticks can be made of silicone varnished glass fiber cloth laminated with silicone adhesives. After assembly, as shown in Fig. 4, the remaining voids are filled by impregnating the equipment and baking it to cure the silicone resin impregnant. Baking conditions equivalent to about 2 hr. at 250° C. are usually required. The combination of silicone resins with inorganic space insulation such as glass fiber, mica and asbestos is being referred to as "high-temperature silicone insulation," or HTS, since no standardized AIEE or NEMA insulation class is applicable.[26]

There has long been a demand for an insulation having better thermal stability than conventional Class B insulation. Designers of electrical equipment have welcomed the new high-temperature silicone insulation because its improved thermal endurance can be utilized in three important ways:[26]

1. To reduce size and weight of electrical equipment, without reduction in service life, where operating temperature can be increased.
2. To increase greatly the service life of insulation when it

[26] G. L. Moses, Westinghouse Eng. *4*, 138–141 (1944).




# Leadership Throughout Industry

In every branch of Industry, executives see that machinery they use or make is Timken Bearing Equipped.

This practice has become so standard that in numerous cases it is just a routine matter. When bearings are needed, Timken Tapered Roller Bearings are specified.

Management knows the matchless record of this product—accepted everywhere as the bearing that delivers sustained, dependable performance. Timken Bearings are used in countless types of war material, automobiles, trucks, tractors, locomotives, streamlined trains and industrial machinery generally.

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*TAPERED ROLLER BEARINGS*

Design, research and experience are the reasons you can trust Timken Roller Bearings no matter how rough and rugged the going.

Your choice of bearings must be selective because the life and operating efficiency of any machine are vitally influenced by the quality of its bearing equipment. The Timken Roller Bearing Company, Canton 6, Ohio.

is necessary or desirable to maintain conventional size, weight and operating temperatures.

3. To permit operation in ambient temperatures and humidities materially higher than those permissible for usual types of insulation.

As much as 50 percent reduction in weight of electrical equipment has been found possible by using the new high-temperature silicone insulation when design limitations are based on insulating temperature. This is illustrated by the two motors shown in Fig. 3. Both deliver 10 hp., but the high-temperature silicone insulated motor in the foreground is half the size and weight of the conventionally insulated motor in the background. The higher safe-operating temperature of the silicone insulated motor makes this possible. Other electrical equipment in which high-temperature silicone insulation is giving increased performance and longer life includes generators, air-cooled transformers and operating coils for magnetic contactors.

## Future possibilities

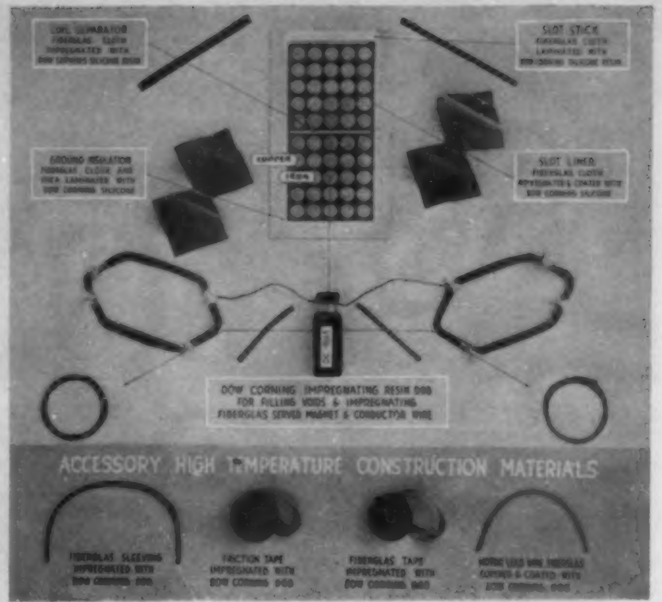
The increased operating temperature made possible by HTS insulation may introduce other problems—particularly mechanical ones, such as allowing for thermal expansion and lubrication of bearings. Silicone greases containing no petroleum-based products or soaps are under development for operation at temperatures up to 200° C.

In small electrical equipment with higher output, such as aircraft motors and generators, the use of silicone resin as a coating on bare copper for magnet and coil wire provides a lower space factor. Silicone resin insulation on the iron core laminations and silicone resin bonded glass-fiber laminated insulating board and coil ends are also required. Silicone resins tailored to the fabricating requirements of these and other articles are now at an advanced stage of development.

Extensive use of high-temperature silicone insulating materials has been predicted even though they are not considered as panaceas for all insulating problems and should be applied to specific equipment where their use is justified.[26] The new silicone resins provide a basis for the greatest advance in electrical insulation since the advent of Fiberglas.

*3—Both of these electric motors produce 10 horsepower. The reason for the increased power in the small motor (which is shown in foreground) is its use of silicone insulation which withstands higher operating temperatures*

PHOTO, COURTESY WESTINGHOUSE ELECTRIC & MFG. CO.




PHOTO, COURTESY DOW CHEMICAL CO.

*4—High temperature silicone insulation*

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933, OF MODERN PLASTICS, published monthly at Easton, Pennsylvania, for November 1, 1944.

State of New York } ss.
County of Kings }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Chas. A. Breskin, who, having been duly sworn according to law, deposes and says that he is the Publisher of the MODERN PLASTICS and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are:
*Publisher*, Chas. A. Breskin, 122 E. 42nd St., New York City.
*Editor*, Chas. A. Breskin, 122 E. 42nd St., New York City.
*Managing Editor*, Dorothy Martin, 122 E. 42nd St., New York City.
*Business Manager*, A. S. Cole, 122 E. 42nd St., New York City.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)
Modern Plastics, Inc., 122 E. 42nd St., New York City.
Chas. A. Breskin, 122 E. 42nd St., New York City.
Mrs. C. A. Breskin, 55 Park Road, Scarsdale, N. Y.
Linda S. Breskin, 55 Park Road, Scarsdale, N. Y.
Theodore B. Breskin, 55 Park Road, Scarsdale, N. Y.
Mrs. Helen K. Cole, 246 Coligni Ave., New Rochelle, N. Y.
S. Moisseiff, 55 Liberty St., New York City.
E. S. Gregg, 111—8th Ave., N. Y. C.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are:
None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

CHARLES A. BRESKIN, Publisher

Sworn to and subscribed before me this 26th day of September, 1944.

[SEAL] HERMAN L. ISLER
Notary Public, Kings County

Kings County Clerk's No. 11, Register's No. 4000
New York County Clerk's No. 36, Register's No. 4-4-14.
(My commission expires March 30, 1944.)

# Going Places!


THIS handsome piece of luggage is covered with a lightweight, water-repellent, durable fabric made of PLEXON yarn. In the post-war days ahead, PLEXON will make a dramatic contribution to the luggage field. It is already being used in the ladies' handbag, shoe, drapery and many other fields.

PLEXON, as you know, is the plastic coated yarn that can be woven or knitted on existing machinery without any changeover. PLEXON is made in various sizes and in a wide range of colors. At the present time, much of our production is on war work, but we are in a position to supply small quantities of experimental PLEXON yarn to those textile mills who are working on their post-war lines.

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*— Plastics Division —*

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IN PLASTICS it's bad business to get the cart before the horse. For instance, a part designed for plastic molding may have related parts to be made of other materials. If the design of the plastic part proves impractical or uneconomical from the standpoint of moldability, it must be redesigned. And, more than likely, the related parts may have to be redesigned also . . . a costly procedure, to say the least.

One way to be sure about these things is to call in a CMPC Development Engineer during the *early* stages of your planning. He'll know whether or not your job can be economically molded in plastics, and if not, he can probably show you how it can be redesigned to make it practical. And he can help you in many other ways too, for he's an integral part of a well rounded organization of plastics specialists . . . laboratory technicians, designers, engineers, production experts . . . with over 25 years' experience in the field. Operating the largest, best equipped custom molding plant in the Middle West, CMPC offers a complete service . . . from designing and engineering through moldmaking, molding, and finishing to on-time delivery in accordance with your own production schedules.

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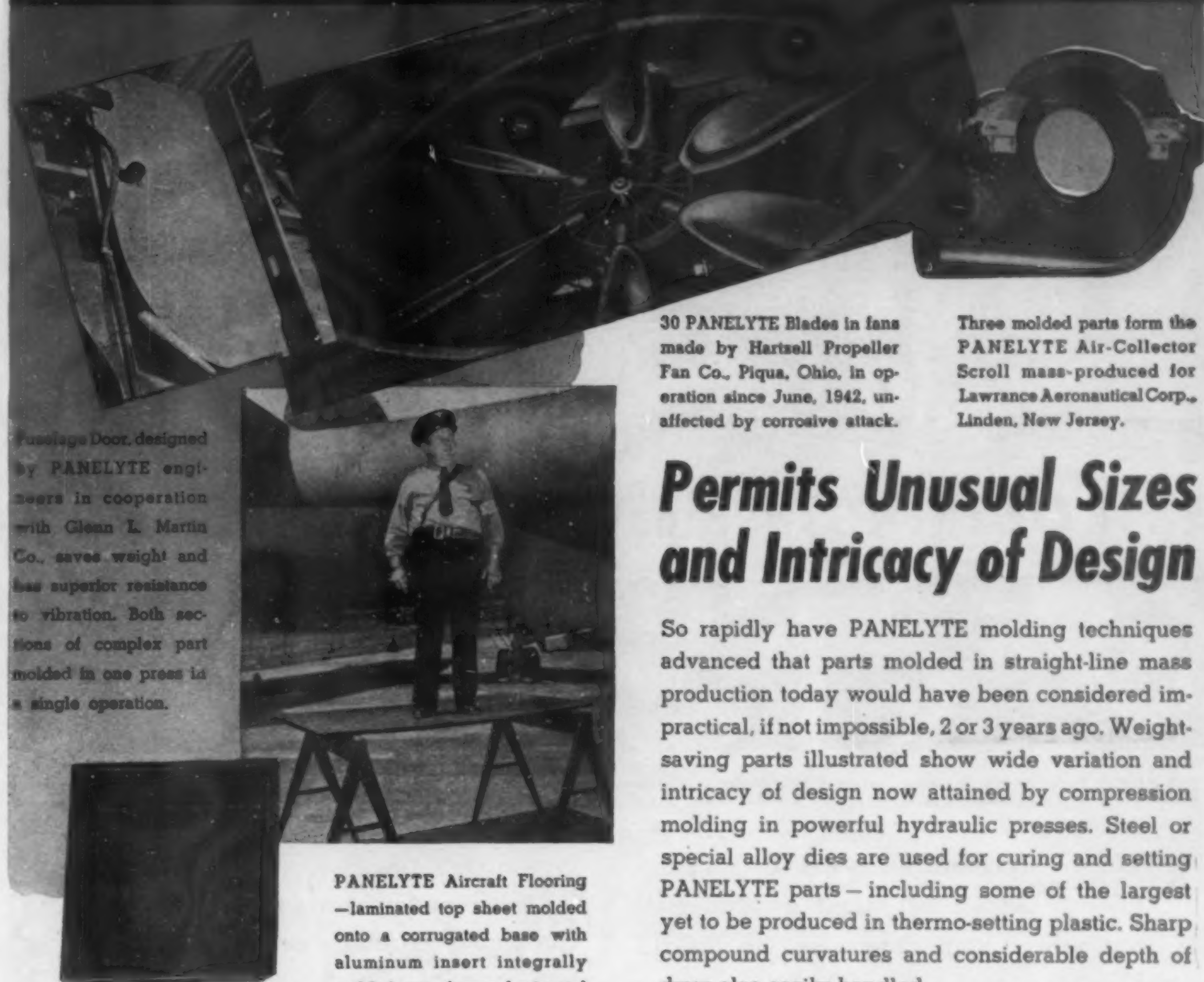
COMPRESSION, INJECTION, AND TRANSFER MOLDING OF ALL PLASTIC MATERIALS

1046 N. Kolmar Ave. Chicago 51, Illinois

# PANELYTE* Precision Molding



30 PANELYTE Blades in fans made by Hartzell Propeller Fan Co., Piqua, Ohio, in operation since June, 1942, unaffected by corrosive attack.

Three molded parts form the PANELYTE Air-Collector Scroll mass-produced for Lawrance Aeronautical Corp., Linden, New Jersey.

Fuselage Door, designed by PANELYTE engineers in cooperation with Glenn L. Martin Co., saves weight and has superior resistance to vibration. Both sections of complex part molded in one press in a single operation.

Navigator's Table Drawer molded of paper base PANELYTE; pull handle is integral part; unit shipped ready to install.

PANELYTE Aircraft Flooring—laminated top sheet molded onto a corrugated base with aluminum insert integrally molded into lower horizontal surface—surpasses all standard floorings in high strength, lightweight characteristics. Developed by Martin engineers and used in Martin "MARS".

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You will find our Engineering Staff of practical assistance in the design and economical production of fabricated as well as molded parts in paper, fabric, fibre glass and asbestos base laminated plastics.

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PHOTO COURTESY ELECTRO-VOICE MICROPHONES

Out of a wide range of tough molding assignments relating to war work, the little earphone of this Signal Corps outfit was one that required more than usual study by the Imperial Molded Products engineering department.

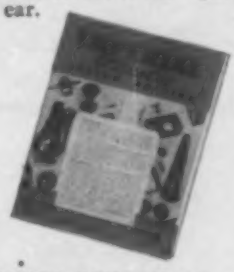
This molding job was a very delicate one as it was necessary to hold the diaphragm position within + or — .001 inch. The molding was further complicated by undercuts and the use of side cores. Very fine threads—40 to the inch—had to be molded on the body and cover.

The successful solution of this earphone molding job on a practical commercial basis is one more indication of the technical service that is available to you through the Imperial Molded organization. If you require a molding service organized to handle tough assignments, as well as the ordinary run of molding work, we shall be pleased to work with you—subject, of course, to present day limitations imposed by war work.

**IMPERIAL MOLDED PRODUCTS CORP., 2927 W Harrison St., Chicago 12, Ill.**

● The plastic parts for the earphone shown here in actual size were produced for the Signal Corps under a sub-contract. This earphone was purposely made extremely small so that a gas mask can readily be used over it.

The new earphone actually gives better reception than the older types. It carries all the vibrations to the ear and excludes outside noise to a large extent, because it fits right into the ear.



**BULLETIN K-200** will give you many interesting details about Imperial Custom Plastic Molding. **Your request will bring a copy.**

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BAKELITE ★ PLASKON ★ MAKALOT
DUREZ ★ TENITE ★ [illegible]TE ★ BEETLE

# HOW FOUR LEADING MANUFACTURERS ARE HELPING SAVE PRECIOUS PAPER FOR UNCLE SAM...

**A BIG OIL COMPANY**—"In 1943 we reduced the number of issues of our house publication from 12 to 6. Our employe house organ was reduced in size as were our dealer window displays, and all promotional material was kept to the smallest possible size."

**A BIG DRUG COMPANY**—"The weight of our corrugated board was reduced to the minimum necessary for protection to our goods in transit. The weight of board used on some items was cut almost in half. We increased the pack per shipping case on many items where doubling of the quantity in each case would not result in an unwieldy or hard-to-lift unit. Nests, partitions and liners were dropped right and left. Package insets have been dropped except on one item."

**A BIG CHEMICAL COMPANY**—"Where 100-pound basic-weight paper had been specified as desirable, the lightest practical weight is now used. All pieces and forms are carefully checked for reduction to next standard smaller size, excessive margins, and number of pages or parts. The Company has adopted single typewriter spacing where practical, typing on both sides of the sheets, pruning lists, and all such miscellaneous practices. Wastepaper at our plants and offices is not burned but baled to reach paper mills for conversion."

**ANOTHER BIG DRUG COMPANY**—"In 1943 we stopped issuing an almanac. We had been sending out around twenty million. We also discontinued our small booklets, the edition of which was some thirty to thirty-five millions. For 1944 we kept the ban on booklets and also cut out the printing of twenty million calendars."

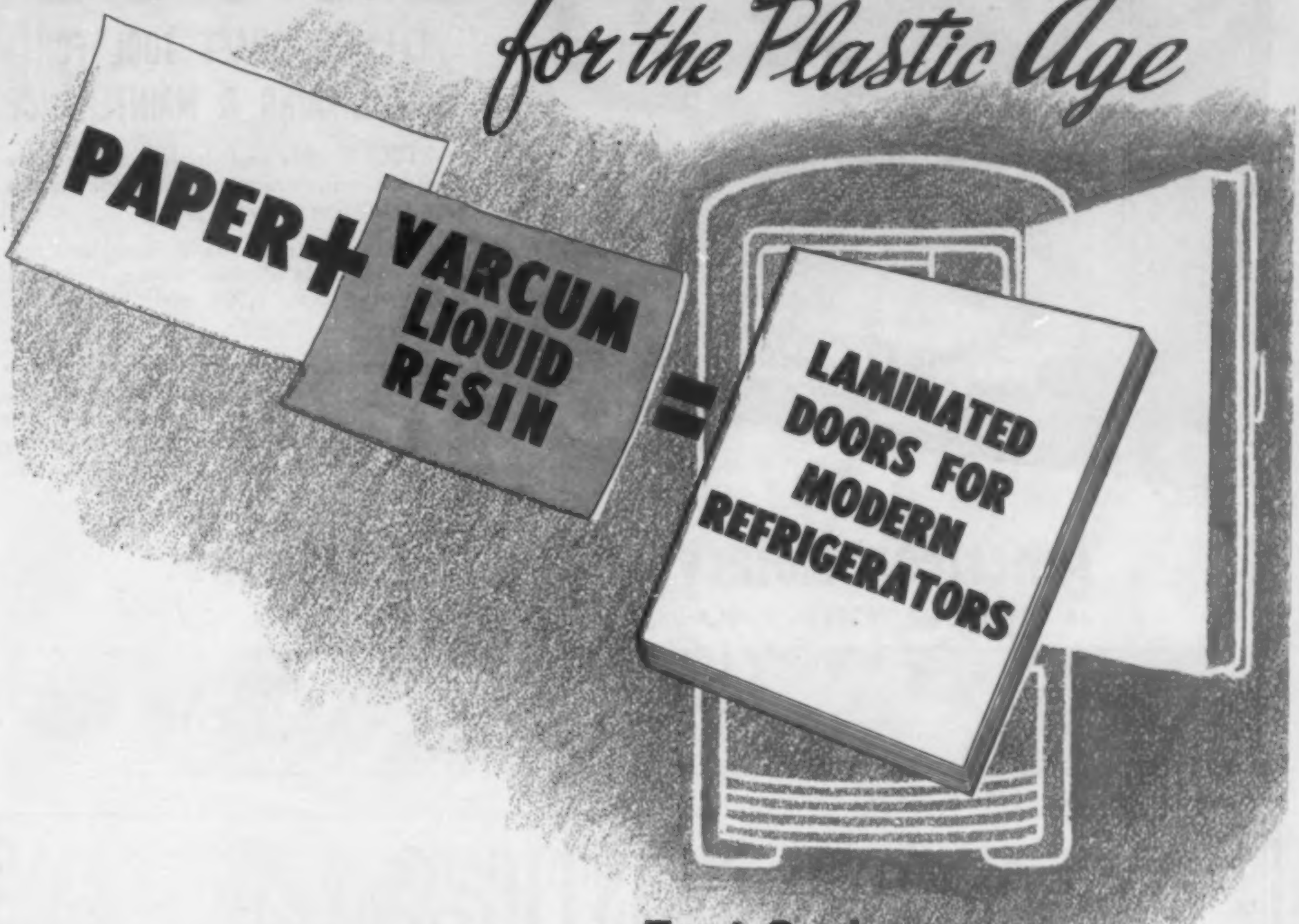
*These quotations are from reports to the A. N. A. Paper Committee.*


*Remember—*
**PAPER IS WAR POWER**

***USE LESS PAPER—SAVE ALL WASTEPAPER***

This advertisement contributed by MODERN PLASTICS and prepared by the War Advertising Council in cooperation with the War Production Board and the Office of War Information.

# ANOTHER VARCUM DEVELOPMENT *for the Plastic Age*




- **Fast Curing**
- **Water Resistant**
- **Insulating**
- **Light in Weight**
- **No Fire Hazard**

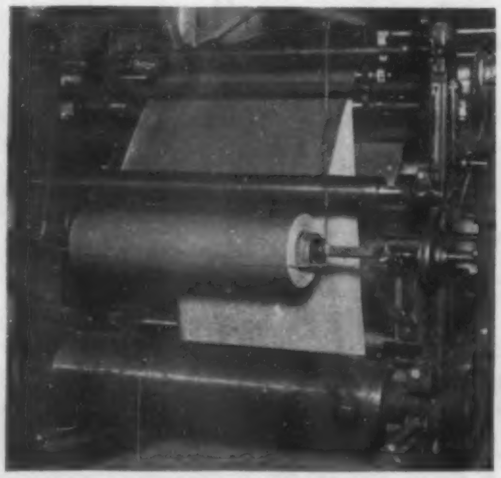


PHOTO SHOWS APPLICATION OF COATING WITH SPECIAL VARCUM RESINS

Based upon developmental work started before the war, special Varcum Liquid Resins for coating paper are today available for the molding of laminated products; for instance the molding of refrigerator door linings.

These linings are highly resistant to moisture and odorless. They are light in weight and provide excellent insulating values.

Varcum Liquid Resins for this purpose are specially formulated to give fast curing. A flat section $\frac{1}{16}''$ thickness can be molded in *less than 1 minute!* What's more, since no solvents are required, both the fire hazard and the cost of volatile solvents are eliminated.

For production speed, for quality, economy and safety, investigate Varcum Liquid Resins for paper coating applications. Your inquiry will receive prompt attention.

★ ★ ★ VARCUM ★ ★ ★

CHEMICAL CORPORATION

NIAGARA FALLS, NEW YORK

# ELMES Simplified Controls can SPEED Your Production

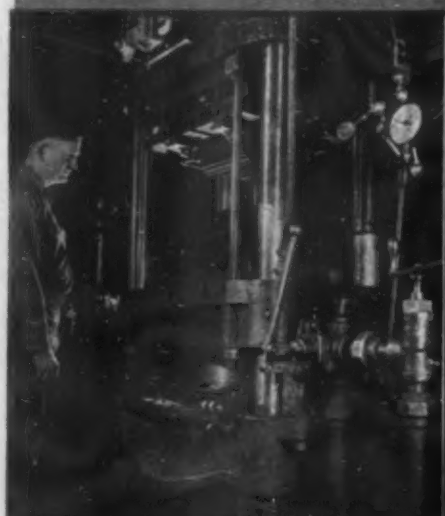
Cabinet-type molding press, semi-automatic, self-contained, adjustable pressure control, automatic breathing cycle.


Give Elmes presses the right molds and mixtures; put the temperature indicator where it should be; set the controls for the cycle you want (breather time can be included)—and the rest is routine. Forty 200-ton Elmes presses at the Victor Mfg. & Gasket Co., for example, have operated twenty-four hours a day since 1937, without a breakdown.

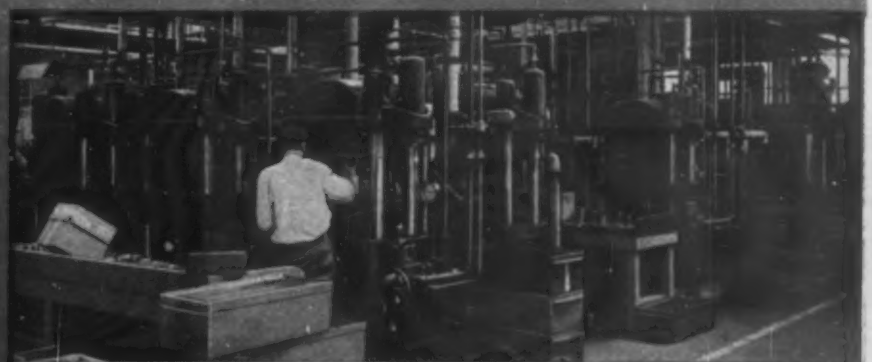
Elmes simplified controls give you fast opening and closing; adjustable pressure; selective molding speed; cycle regulation; temperature variation; push-button operation—all with minimum attention. Elmes sturdy construction gives you rigidity, dependability, and durability.

Put your pressing problems up to Elmes. Elmes Engineering Works of American Steel Foundries, 225 N. Morgan St., Chicago 7. Also manufactured in Canada.

Industrial Molded Products Co., Chicago, has twelve Elmes presses in continuous service.



A few of the forty Elmes 200-ton presses at Victor Mfg. & Gasket Co., Chicago. All have operated twenty-four hours a day since 1937, without a breakdown.



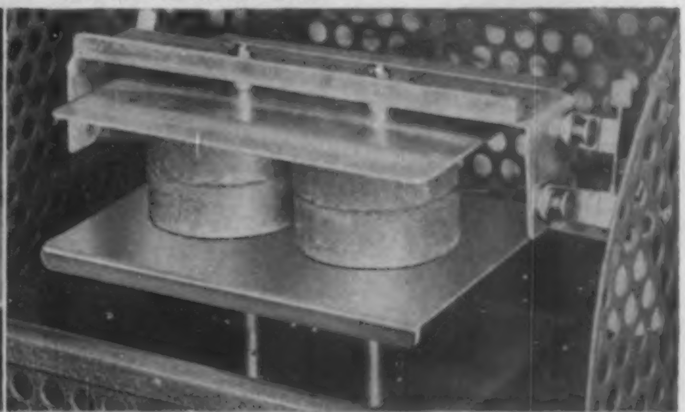
## ELMES HYDRAULIC EQUIPMENT

METAL-WORKING PRESSES · PLASTIC-MOLDING PRESSES · EXTRUSION PRESSES · PUMPS · ACCUMULATORS · VALVES · ACCESSORIES

# FASTER, BETTER MOLDING with *Airtronics* PREHEATERS Insured by Advanced Design

The symmetry, simplicity and rugged construction of the AIRTRONICS Model CB Oscillator and power transmission elements are shown above.


AIRTRONICS Model CB Control Panel. Adjustment of power output and preheating time made in a few seconds with Set-up, Power and Timer Controls. No special training necessary.



AIRTRONICS Model CB Self-Aligning output electrodes. Safety switch turns off power when hood is raised.

*Developed expressly for plastics molders—who needed electronic preheating equipment that was more dependable, more versatile and easier to operate—AIRTRONICS units have established* enviable *records throughout the plastics industry. Exclusive features of AIRTRONICS design are responsible for* these *higher standards of performance...*

## Efficient Power Generation

Heart of the AIRTRONICS Preheater is the *Electronic Oscillator,* which generates the high-frequency power. Electrical and mechanical symmetry and simplicity, high efficiency and extraordinary stability characterize the AIRTRONICS design

## Low-Loss Power Transmission

Unique AIRTRONICS transformer, transmission and coupling elements transmit high-frequency energy from oscillator to load with minimum power loss.

## Quick, Easy Adjustment

Two simple controls regulate the output for each type and arrangement of preforms. Optimum adjustment requires only *SECONDS* to make.

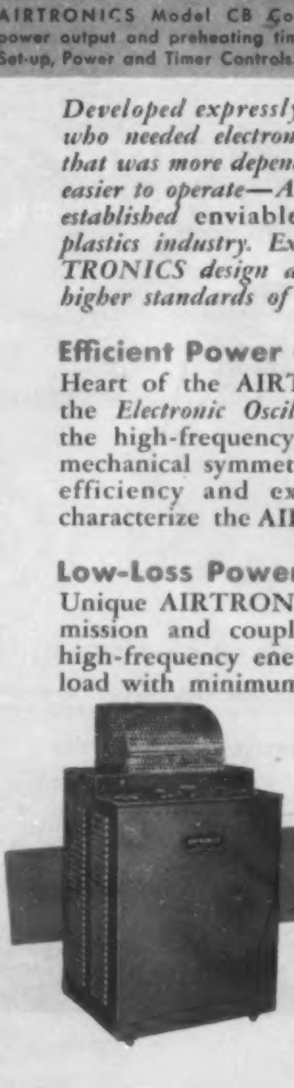
## Wide Range of Application

Exclusive AIRTRONICS self-aligning electrodes instantly accomodate preforms up to 3" in thickness. Convenient adjustments regulate air gap between preforms and upper electrode. Special electrodes available for uniform preheating of unusually shaped preforms.

## Write for Complete Details

Send for illustrated literature on AIRTRONICS Preheaters. Models available with average charge capacities of 1 lb. per minute, 5 lb. per minute, 10 lb. per minute.

Address inquiries to Dept. MP.



*Airtronics* MANUFACTURING CO.

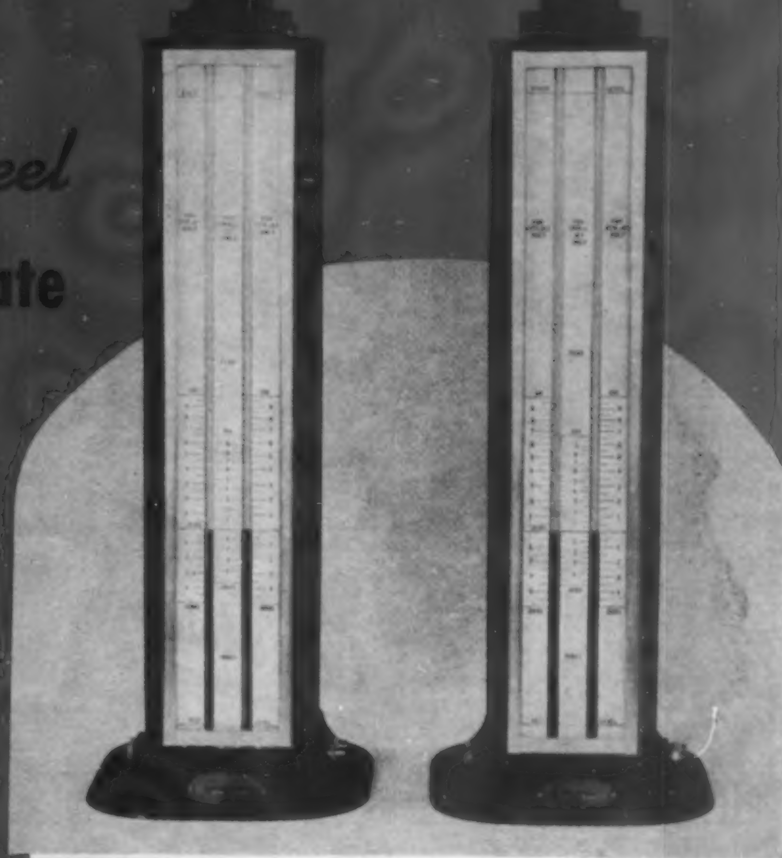
| CHICAGO | NEW YORK | LOS ANGELES |
|---|---|---|
| 121 W. Wacker Drive | 31-28 Queens Blvd. | 5245 W. San Fernando Rd. |
| Zone 1 | Long Island City, Zone 1 | Zone 26 |

# METRICAL LABORATORIES, INC.

rely on

*Graph-Mo Steel*

to produce accurate gauges . . .



The Metricator, an air-actuated gauge, manufactured by Metrical Laboratories Inc., Ann Arbor, Michigan, is built with an magnification ratio of 1 to 4000. It indicates .001″ to be 4″ on its scale and is accurate to .00001″.

To assure this precise accuracy master gauges and gauging heads used with the Metricator are made of Timken Graph-Mo Steel lapped to exceptionally close tolerances.

Graph-Mo was chosen as the material for master gauges and gauging heads because this performance proven steel has only a minimum of growth enabling gauges to remain accurate and eliminating the necessity for costly repairs.

In addition Graph-Mo has excellent machinability, good response to heat treatment, offers stubborn resistance to wear and has less tendency to seize than competing steels. All excellent qualities that will prove to be good allies in licking the tough competition that lies ahead. Steel and Tube Division, The Timken Roller Bearing Company, Canton 6, Ohio.

*A request on your firm's letterhead will bring an illustrated 48 page booklet full of good sound information about all of the Graphitic Steels, Graph-Mo, Graph-Tung, Graph-Sil, Graph-Al, Graph-M.N.S.*

**TIMKEN**

TRADE-MARK REG. U. S. PAT. OFF.

***GRAPHITIC STEELS***

# *Plastics* SCRAP
## WILL HELP WIN THIS WAR

We specialize in the reworking of
rejected molded parts
obsolete molding powders
or molding scrap
into solid colors of a good molding powder
in any desired flow

**A. BAMBERGER**
*Plastics Molding Materials*
109 SOUTH 5th STREET BROOKLYN, N. Y.
Cable: Chemprod — Telephone: EVergreen 7-3887

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Complete Line of

**Machinery for Celluloid and Plastics Mfrs.**

**JOHN J. CAVAGNARO**

HARRISON Engineers and Machinists ESTABLISHED 1881 NEW JERSEY


**Mixers: Plain or Stainless
Preliminary or Vacuum**

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# PLASTIC MOLDS

25 years experience in designing and building molds for leading molders.

Our plant is modern in equipment for producing the best in molds. Compression, Injection, Transfer.

MEMBER SOCIETY OF THE PLASTICS INDUSTRY · SPI ·

***FORTNEY MFG. CO.***
**247 N.J. R.R. Ave.**
***NEWARK, N. J.***


# Your Good Name

Name plates for your products, receive special attention from us. They carry your good name on your products which make them a personal kind of business that we like.

Whether your design is plain or decorative, one color or more, we will welcome your post-war orders. Write us now and your post-war planning on this part of your product will be well on its way.

INJECTION MOLDED PLASTICS

**MINCOR**

"YOUR PLASTICS DEPARTMENT"

TENITE I . TENITE II . VINYLITE . LUCITE
POLYSTYRENE . LUMARITH . PLEXIGLASS

★

**MINNESOTA PLASTICS CORPORATION**

SAINT PAUL 1, MINNESOTA

# S-P-E-E-D

YOUR PRODUCTION WITH

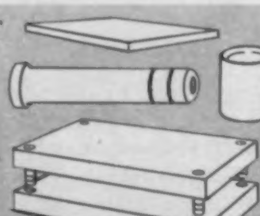
# DME STANDARD MOLD BASES

5 BASIC SIZES
16 COMBINATIONS
IN EACH SIZE
A TOTAL OF **80** MOLD BASES TO CHOOSE FROM

FOR *Injection Molding*

- Made in all popular sizes to meet every practical requirement.
- Come to you complete—ready to insert cavities, ejector pins, etc.,—most of the designing work is done for you.
- Simplify your mold-building problems.
- Cost less than custom-made mold bases.
- Eliminate costly errors experienced in custom-built mold bases.
- Interchangeable parts—can be used repeatedly for further setups.
- Machine hours and man hours saved—get you into production *faster*.
- Provide better, more economical injection molding.

*Learn fully about DME Standard Mold Bases and how they can solve your production problems.*



## DME MOLD PARTS

*for Injection and Compression Molds*

Standard parts in many sizes—machined to very close tolerances—enable you to quickly build up your own molds.

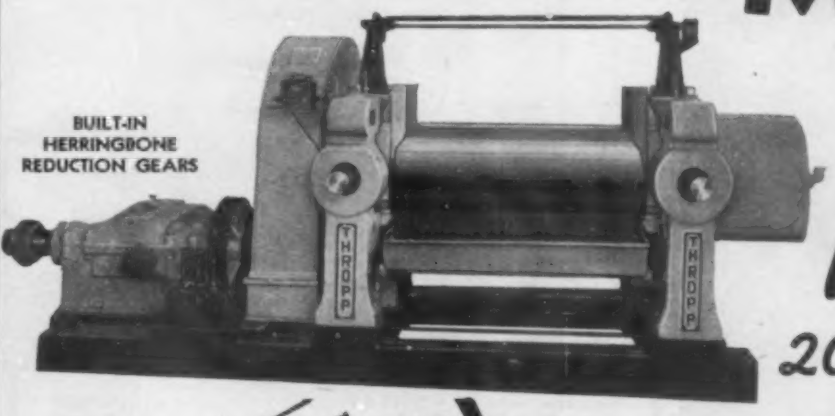
DME NEWS will be mailed you monthly upon your request.

DME

**DETROIT MOLD ENGINEERING COMPANY**

4837 WOODWARD AVENUE • DETROIT 1, MICHIGAN


# Extra Heavy Duty MILLS for Plastics




## 20" & 22" x 60"

**Plan NOW for Quick Conversion**

If your post war plans for greater production call for special plastic machinery, we invite you to submit them to Thropp Engineers NOW. They will gladly work with you in designing custom built mills for your particular requirements to enable you to convert quickly to peace time production. Write NOW!

Thropp 60-inch, heavy duty Mills have extra heavy necks and are constructed to stand hard, continuous service and speed up production.

For this and other types of Thropp production and laboratory mills designed for plastics, all custom built to meet special requirements, consult our engineers.

**WM. R. THROPP & SONS CO.**
**Trenton, New Jersey**

# THE CARVER LABORATORY PRESS

## STANDARD FOR RESEARCH AND DEVELOPMENT

*Distinguished by its wide acceptance in the plastics industry, the Carver Laboratory Press is standard*

... for making quick and accurate small-scale pressing tests.
... for development, research and instruction work.
... for testing single cavity molds.
... for preparation of samples.
... and even for small-scale production.

*Original in design, the Carver Laboratory Press is small, compact,*

... has a pressing capacity of 20,000 lbs.
... weighs only 125 lbs.
... operates under self-contained hydraulic unit.
... large accurate gauge of finest construction is rigidly mounted on base.
... special gauges are available for low pressure work.

Carver accessories include steam and electric hot plates and test cylinders or molds. Also standard interchangeable accessories are available for general research—cage equipment, bearing plates, filtering equipment, etc. The press and certain of the accessories are patented. PROMPT DELIVERIES FROM STOCK. Send now for latest catalog.

**FRED S. CARVER**
**HYDRAULIC EQUIPMENT**
**343 HUDSON ST., NEW YORK 14**

## UNITS WITH OUTPUTS *from* 500W to 15KW

*One of the*

# Thermatron

*Family of Electronic H. F. Heaters*

The unit pictured is a special purpose equipment, designed for operation by inexperienced help. Note its simplicity, and the protected position of adjustment dials—in use covered by a plate.

To learn of the advantages of high frequency for heating preforms, in extruding, in welding thermoplastics or other applications, outline your problem to us.

A wealth of application engineering experience will be placed at your disposal.

**Thermatron Division**
Airway & Airport Radio — Industrial Electronics

**RADIO RECEPTOR CO., INC.**
251 West 19th Street — New York 11, N. Y.
SINCE 1922 IN RADIO AND ELECTRONICS

## *Toward New Horizons*

Post-war programs contemplate many new products in which wood cellulose may be used effectively and economically. These new products must be developed carefully and methodically. Our technical knowledge and experience is available for translation into new pulps to meet the specific chemical and physical requirements of peace-time products. By studying your problems now — in close relationship with our technical staff—a more purposed and effective approach is assured.

**RAYONIER**
INCORPORATED

SALES AND EXECUTIVE OFFICES:
122 E. 42ND ST., NEW YORK 17, N. Y.

BETTER *Pulps* FOR BETTER PERFORMANCE

All classified advertising payable in advance of publication. Minimum, $5.00 (up to 60 words); in border, $10.00 per inch.

# Classified Advertisements

For further information address Classified Advertising Dept. MODERN PLASTICS 122 East 42nd St., New York 17, N. Y.

As its contribution to orderly re-employment, MODERN PLASTICS will print free of charge in its "Positions Wanted" classification one ad, not to exceed twenty words, for each honorably discharged veteran of the armed forces of the United Nations who has had previous plastic experience.

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Arthur Swanson & Associates

PRODUCT DESIGN

Executing designs for post-war manufacturing

540 N. Michigan Ave., Chicago 11, Ill.

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WANTED: PLASTIC SCRAP OR REJECTS in any form. Cellulose Acetate, Butyrate, Polystyrene, Acrylic, Vinyl Resin, etc. Also wanted surplus lots of phenolic and urea molding materials. Custom grinding and magnetizing. Reply Box 318, Modern Plastics.

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WANTED: THERMOPLASTIC SCRAP or rejects in any form, including Acetate, Butyrate, Styrene, Acrylic and Vinyl Resin materials. Submit samples and details of quantities, grades and color for our quotations. Reply Box 508, Modern Plastics.

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FOR SALE: 1—500 ton Hydraulic Press with downward moving ram and pushbacks. Box 512, Modern Plastics.

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WANTED: Small or medium sized plastic molding plant with either hydraulic extrusion or injection equipment with or without tool shop. Advise full details. Reply Box 788, Modern Plastics.

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FOR SALE—1 Worthington Hyd. Pump 1 x 6, 5 GPM 6000 pressure M.D. 1 Hyd. Press 24" x 24", 14" ram; 1 Battery of 2—15 x 36 compounding rolls with drive at 75 HP motor; 1 W. S. 15" x 18" Hyd. Press, 10" ram; 1—14" x 24" Press, 9" ram; 4—24" x 55" steel cord Heating Platens; 4—W. & P. Mixers; 4—Semi-Automatic 100-ton Hydr. Presses, platen area 20" x 36"; Allen 6" Tuber; Dry Powder Mixers; Pulverizers, Grinders, etc. Send for complete list. Reply Box 447, Modern Plastics.

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IN THE MARKET FOR: Stainless Steel or Nickel Kettles, Vacuum Pan, Preform Machine and Mixer, Hydraulic Presses. Reply Box 825, Modern Plastics.

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ATTENTION MANUFACTURERS.

Sales promotion executive, Plastics Institute graduate, highly successful, nation wide contacts with chain store organizations, long established New York Office, will promote new products or old on commission arrangement now, or when available. Shipping facilities and financing at your option. Please write to Box 1058, Modern Plastics.

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TWO ENTERPRISING YOUNG MEN with excellent references seek contact with manufacturers to begin immediate sales of plastic products throughout California. Desire agencies for homeware and novelty products in particular. If interested write Box 1079, Modern Plastics, as we are able to assume complete sales cost.

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Well known and established Sales Engineering Office covering Philadelphia and adjacent Pennsylvania, Delaware and Maryland territory wishes to make connection as Representatives on full territory protection basis. Knowledge of the Plastic Industry. Interested in Compression and Injection, Transfer, Extrusion and/or Plastic Fabricators accounts. Good clientele. Have good Post War business to place now. Reply Box 1104, Modern Plastics.

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SALES REPRESENTATIVE needed for Philadelphia area by New England Manufacturer specializing in compression, transfer, and injection molding. Box 1105, Modern Plastics.

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Ph.D. PHYSICIST, completing present war work. Unusual background of training and research. Expert in fundamental physics and its instruments; vacuum tube and electroacoustic instrument design; properties, development and manufacture of rubber and plastics. Experienced industrial planner, research and development director. Box 1098, Modern Plastics.

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MANUFACTURER'S AGENT—Seasoned salesman desires to contact reputable manufacturer of plastics, molded or laminated, or possibly plastic resins and compounds, who seeks effective representation in the fertile New England territory. Boston headquarters. Good background and connections; can assure the right account energetic sales effort. Reply Box 1096, Modern Plastics.

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POSTWAR PROFIT PLANNING

Cost Analyst and Industrial Engineer with 15 years of Production, Industrial Engineering and Accounting experience will accept special assignments on Cost analysis, Estimating, Pricing, Production Control problems and Operation Standardization.

Regular contributor to technical publications on Management and Plant Control problems.

Eastern part of U. S. A. preferred.

Box 1099, Modern Plastics.

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WANTED

Compression Molding Press, 100 ton capacity, Platens 20" x 20", self contained pumping unit, electrically heated preferred.

ERIE BASIN METAL PRODUCTS, INC.
(Purchasing Department)
Elgin, Illinois

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FOR SALE—One Aldrich hydraulic pump, complete with motor. Motor 900 rpms, 3-phase, 60-cycle, 220-volt. Pump capacity 10, size 1½ x 7, lift 2500 lbs. Reply Box 1106, Modern Plastics.

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INDUSTRIAL ENGINEER would like position with a reliable and aggressive custom molding company. Experience covers job evaluation, wage incentives, production control and methods. Have 6 yrs. experience of which 3 were in plastic molding. Reply Box 1107, Modern Plastics.

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SALESMEN—With established industrial contacts, now representing injection or compression moulders, desirous of rounding out their line and service. Large eastern extrusion organization, engaged in war work, wants representation in cites east of Chicago. Splendid opportunity for substantial earnings on commission basis. Every cooperation. Write in detail to Box 1108, Modern Plastics.

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FOR SALE: One Grundler Hammermill also known as "Wood Hog" model 4XA. Also has 93 extra new hammers, and machine is in first class condition. Address Box 1109, Modern Plastics.

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SALES ENGINEERING organization, located in New York City with associated Philadelphia office, now representing a Mid-west plastic molder, desires to make a connection with a molder nearer their immediate markets. Have some post-war items to place with new connection, therefore immediate negotiations will be appreciated. Can furnish excellent references and established offices. Box 1110, Modern Plastics.

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WANTED: 1—2 or 3 hp Mears, Kane & Ofeldt Steam Boiler 200 pound construction. Used Hydraulic Press suitable for molding small parts. Reply Box 124, Wayne, Pa.

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CLEAR COMPRESSION LUCITE

Virgin, in storage several years, no allocation needed. Up to 10,000 lbs. available. Make offer, will ship subject to inspection. Box 1111, Modern Plastics.

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PLASTIC MOLD ENGINEER—A large manufacturer of plastic molded parts wants a mold engineer whose duties would include designing injection and compression molds. Permanent post war position. Excellent future. State salary and previous experience in letter to Pro-phy-lac-tic Brush Company, Florence, Mass. Attention: Personnel Manager.

---

MANUFACTURERS' AGENT, with office in Detroit, desires product to sell to automotive industry. Have excellent contacts in the trade. Box 1112, Modern Plastics.

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CHEMICAL ENGINEER: B.Ch.E. accredited eastern school, 27, married, 2-A(L) deferment. Would like permanent position with plastic firm in East. Have had extensive experience in production, development, and operation in large viscose rayon plant; also experience in industrial engineering and management consultant work. Reply Box 1113, Modern Plastics.

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PLASTICS CHEMIST, M.S. Desires change. Four years experience in research and development of synthetic resins and varnishes, all phases of laminated plastics, and lignin molding powders. Familiar with manufacturing processes. Excellent academic background in organic research. Leadership ability. Desires responsible position utilizing training and experience more fully than present position. Young, married. Release obtainable. Reply Box 1114, Modern Plastics.

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PLASTIC MANUFACTURERS

Successful, established firm seeks manufacturer equipped to make low priced photo frames, complete or parts, can use large steady volume. Box 1115, Modern Plastics.

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WANTED by Midwest Plastics Fabricator—A young man thoroughly acquainted with the application of thermoplastic materials to take charge of small growing Plastics Department. Give full details and salary desired in your reply. Reply Box 1116, Modern Plastics.

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WANTED

Tool Room Foreman with experience in compression, transfer, and injection molds to take charge of tool room for a fast expanding well known midwestern plastic molding plant. Excellent opportunity. Communicate at once giving all qualifications. Box 1117, Modern Plastics.

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REPRESENTATION IN N. Y. CITY

Plastic and Wood Products sales organization, headed by aggressive idea-men with machine shop experience and technical knowledge, is offering, now, representation in a New York office. Molders, manufacturers and fabricators who are planning for big post-war sales please reply. Box 1118, Modern Plastics.

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3—16 x 36" Farrel Mills, 2 Calenders, 1—2 roll Hot Calender, 1—#2 Royle Tubing Machine, 1 Southwark Triplex Hydraulic Pump 3¼" x 12", 1—Worthington Duplex Pump 12 x 4 x 12 stainless steel rods, 4 Spreaders for either resins or rubber, 1 Deane Triplex Pump 1" x 6". Reply Box 1119, Modern Plastics.

**FOUNDRY REPRESENTATIVE and Consultant** Chemical Engineer with Foundry Experience in the use of Thermo-setting Plastics both Phenolic and Urea Formaldehyde types wishes position with Plastics Manufacturer interested in Foundry Products or Development of same. Familiar with sand practices of both. Ferrous and Non-Ferrous Foundries. Reply Box 1120, Modern Plastics.

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**EXPORT TO CHILE**—Established firm in Santiago de Chile seeks agencies of U. S. producers of plastics: 1) materials, primarily sheets, rods and tubes; 2) molded products, such as buttons, jewelry; 3) finished products for industrial purposes, especially electro-industry. Suggestions of other products will be appreciated and carefully studied. Reply Box 1121, Modern Plastics.

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**WANTED**—One 3 roll laboratory size calender, approximately 6" x 12". Reply Box 1122, Modern Plastics.

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We are a newly incorporated corporation and we produce dies and tools and instruments of tungsten carbide, and of stainless steel, where feasible. We make dies and jets for extrusion down to hole sizes .0008" in stainless and in carbide down to .002" finished size.
We make stamping dies and the like, drawing dies, bushings, etc., in carbides up to any size, in particular to 5" dia. and 5" height.
We do chromium plating work for you, resp. for customers and recut dies and gages and tools. Reply Box 1123, Modern Plastics.

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**WANTED**: Small or medium size plastic injection molding plant, with or without tool shop. Advise full details. Detroit Production Company, 910 Majestic Bldg., Detroit 26, Michigan.

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**FOR SALE**: Hydraulic Presses—8—Elmes down stroke with spring pull backs, 10 x 14" platen, 4" ram, 9" dalite, built for 4000 lbs. line pressure. 7—Watson-Stillman Arbor bench type, 2¼" ram, double acting, 14 x 14" bed, 10" throat, 14" dalite, built for 2500 lbs. pressure. Loeb Equipment Supply Co., 910 N. Marshfield, Chicago 22.

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**COMBS**

Established concern with nation-wide sales-organization seeks financial connection with moulder, who has some dies. Additional dies and machinery will be furnished. Reply Box 1125, Modern Plastics.

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**OUTSTANDING OPPORTUNITY for CHEMICAL EXECUTIVE**

Capable of earning a substantial five figure salary, plus bonus—to direct Chemical and Sales Research—to coordinate distribution and production—and to direct the training of personnel for the further exploitation of resins and emulsions, particularly in the adhesive, textile, paper and construction fields.
The man must be creative, practical, and have a record of successful leadership where this kind of ability and experience has been employed. Preferred age 37 to 45.
In addition to being the leader in its major field, both on war and peacetime products, the Company has developed substantial sales on resinous emulsions, as well as consistently demonstrating its progressiveness over many years. Location—New York City.
Give sufficient information in first letter to warrant a personal conference with our chief executives. Your confidence will be fully respected.
Box 1126, Modern Plastics.

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**ATTENTION MANUFACTURERS**: Man with thorough factory, sales, engineering, tool design and executive experience with low pressure laminates is interested in affiliation as exclusive consultant for aggressive, well financed and well managed firm planning to enter the laminating and molding field. Can establish growing organization from scratch and will consider permanent employment after initial period. Reply Box 1124, Modern Plastics.

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**ELECTRONIC ENGINEER**

**High Frequency Heating Experience**

Good postwar opportunity for well qualified electronic engineer with broad experience in designing high frequency dielectric and induction heating equipment.
Executive ability and good personality required in this responsible position handling a group of engineers.
Familiarity with equipment requirements of plastics and rubber industries desirable.
State age, education, experience, draft status in letter to Box 1127, Modern Plastics. Statement of availability required.

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**FOR SALE**: Watson-Stillman 225 ton Transfer Molding Press; 12—Molding Presses 50 to 150 ton; Farrel-Birmingham 36" x 36", 12" Ram; Grigoleit 23" x 18", 13" Ram; Morane 30" x 36", 10" Ram; Birm. 24" x 24", 9" Ram; 24" x 24", 7" Ram; Watson-Stillman Hydr. Presses—12" x 12", 7½" Ram; 24" x 36", 6" Ram; 22" x 24", 5⅛" Ram; 25" x 36", Two 5" Rams; 48" x 26", four 3½" Rams; 78" x 36", two 7½" Rams; 40 ton Downstroke Broaching Press; 400 ton Hydr. Extrusion Press; Others up to 1600 ton; W. S. 4 plgr. High & Low Pressure Pump; H. P. M. Vert. 2 plgr., High & Low Pressure; W. S. 1¾" x 12" Horiz. 4 plgr., 30 GPM, 3500 lbs.; Wat.-Farrel 1¼" x 4", Vert. Triplex, 6½ GPM, 3500 lbs.; Goulds 2¼" x 8" vert. Triplex 30 GPM, 1600 lbs.; 4½" x 12" Horiz. 4 plgr., 165 GPM, 900 lbs.; Elmes 1¼" x 4" Horiz. 4 plgr., 8½ GPM, 3600 lbs.; 1" x 4" & 1⅛" x 4" Horiz. 4 plgr., 5 to 6½ GPM, 4500 lbs. & 5500 lbs.; Hele-Shaw Oil Pump, 25 GPM, 1200 lbs.; Hydr. Steam Pumps up to 150 GPM; Low Pressure Pumps; Hydr. Accumulators, Tank & Weighted Types; Royle #2 Extruder; ½" & ¾" Preform Tablet Machines. Heavy duty double arm Mixers up to 150 gals.; Ball & Jewell Rotary Cutters; Grinders, Pulverizers, Gas Boilers, etc. ONLY PARTIAL LISTING. SEND US YOUR INQUIRIES. WE ALSO BUY YOUR USED MACHINERY. STEIN EQUIPMENT CO., 426 BROOME ST., NEW YORK 13, N. Y. CANAL 6-8147.

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**QUALIFIED PLASTICS MAN** seeks position in technical sales capacity with progressive company. Several years of prior experience in industrial plant operations with leading plastics molding concern. Will travel. Reply Box 1129, Modern Plastics.

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**FOR SALE**: Watson-Stillman 225 ton Transfer Molding Press. Has 8½" diameter Vertical Cylinder and 15¾" diameter Horizontal Cylinder. Complete with pressure regulating valve & operating valve. Very late type. Excellent condition. Like new. Can be inspected in operation. Reply Box 1128, Modern Plastics.

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**FOR SALE**: Hydraulic Presses, 600 ton Watson Stillman 24" x 24", 1—36" x 36", 12" ram, 4—2 post 20" x 20" 8" rams, 1—52" x 26" 14" ram, 3—12" x 12" 7½" rams, 1—20" x 20" 14" ram, 2—30" x 52" 1 with 15" ram 4 openings, 1 with 6" ram 3 openings, 1—26" x 45" 10" ram, 1—38" dia. 12" ram pump attached, 1—14" x 20" Combination Hydraulic Toggle, Pumps, 1—Watson Stillman duplex high and low pressure ¾ GPM 4000 lbs. continuous bedplate, Hele Shaw JLP 12, 44 GPM 1200 lbs., HPM triplex 1¾ GPM 2000 lbs. on high 16 GPM 400 lbs. on low V Belt drive, Robertson Triplex 5 GPM 5000 lbs., Union Steam Pump Viscolizer 5 GPM 2500 lbs., 2 Hauser 4 plunger 4.6 GPM 5000 lbs. on high 20 GPM 500 lbs. on low; Gould triplex 35 GPM 1500 lbs., 1 National 1" x 3" Triplex 4000 lbs., Accumulators 9 GPS 6000 lbs. Watson Stillman Hydro-pneumatic, weighted type, 1—5" dia. 6' stroke ram, 1—8" dia. 6' stroke ram, Extruders, Mills, Calenders, Mixers, etc. Advise your requirements. HIGHEST PRICES PAID FOR YOUR USED EQUIPMENT. Universal Hydraulic Machinery Company, 285 Hudson Street, New York City 13.

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**EUROPEAN REPRESENTATION**

Well established Sales Organization with London showrooms wishes contact enterprising manufacturer capable producing plastic products suitable British and European markets. Excellent connection all important Departmental and Chain Stores. Representative visiting America soon as possible when details can be discussed. If interested write Mayfield Supply Company, 37/38 Golden Square, London, W. 1.

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**WANTED TO PURCHASE**—small plastic molding plant, preferably in the middle west. Reply Box 1135, Modern Plastics.

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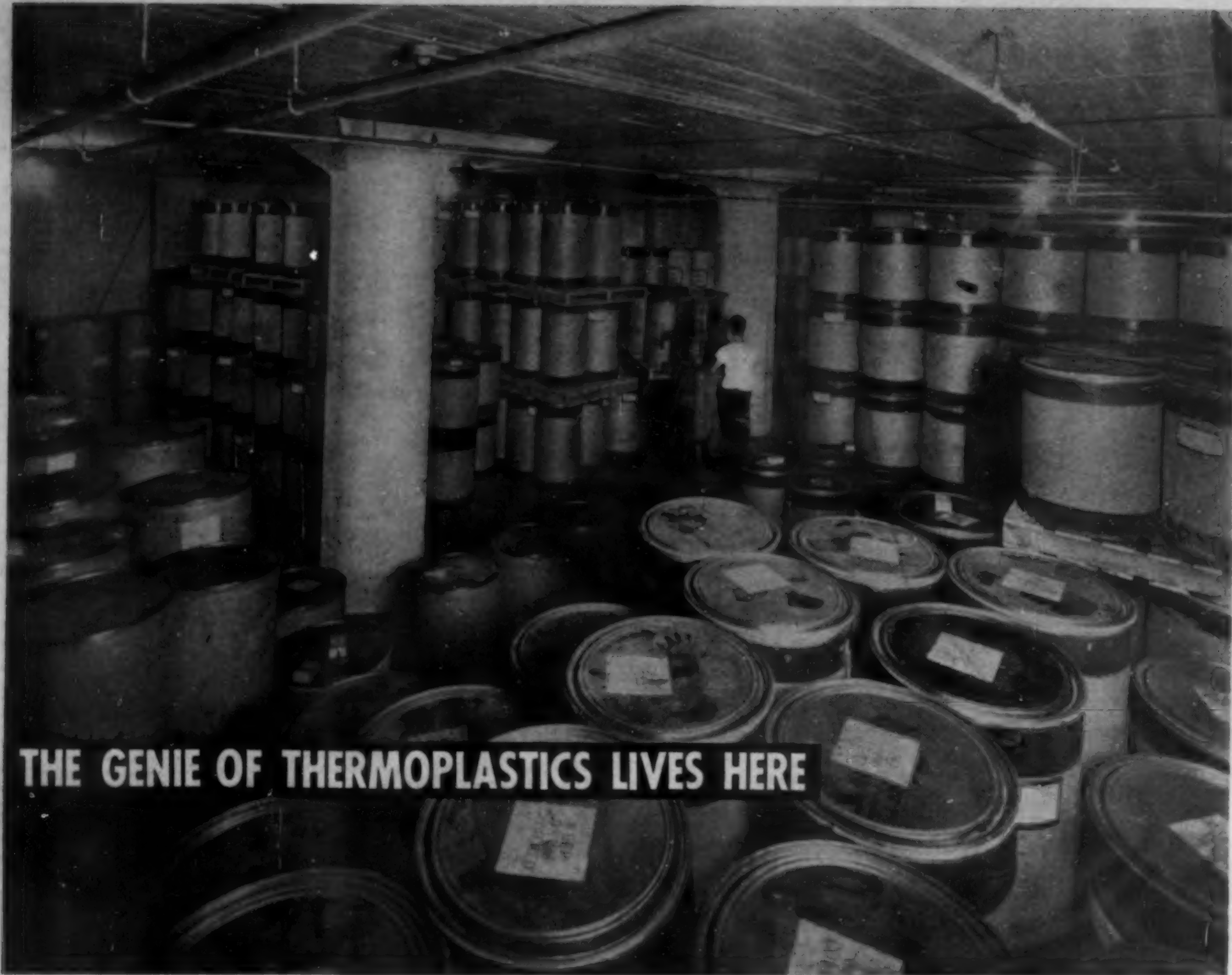

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